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What Is the Future of Mapping From the Air?

J. B. MERTIE, JR., of the U.S. Geological Survey, after a wartime experience with mapping from the air, gives the answer in an article in this issue.

ALSO IN THIS ISSUE:

Design of New Superstructure of Louisville Bridge, with 644-Foot Riveted Span

Historic bridge one mile long replaced by double-track spans on same masonry piers.

Sinking a 30-Foot Concrete Cylinder, Using Ratchet Wrenches Tied Together for Simultaneous Movement

By KEITH O. GUTHRIE

Inspection of Drainage Ditch Cross-Sections After Contract Dredging

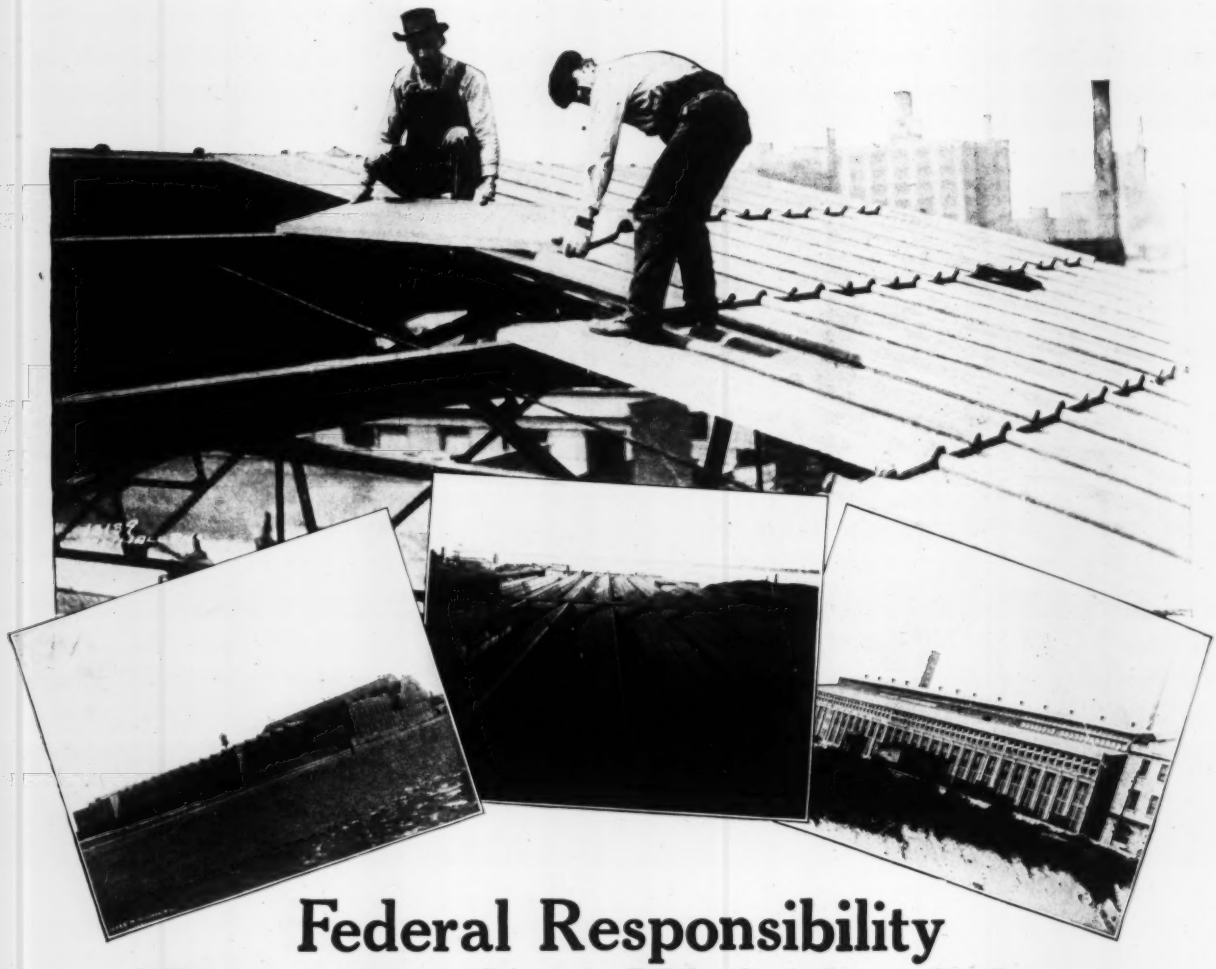
By E. S. BLAINE

Murman Railroad New Outlet to Sea in Russia

Ice-free port on the Gulf of Kola is reached by connection from Northern Railroad—Freight from Siberia for export provided with shorter route.

By V. GORIACHKOVSKY

May 22, 1919



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ENGINEERING NEWS-RECORD

A WEEKLY JOURNAL
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E. J. Mehren, Editor — Charles Whiting Baker, Consulting Editor

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Engineering Impossibilities

NO DOUBT there is much truth back of the optimistic saying that to the engineer nothing is impossible. For those who take the saying literally a near-metropolitan daily offers an excellent problem. Speaking of the proposed vehicle tunnel under the Hudson River, the paper says: "Shall the proposed vehicular tunnel be a twin tunnel, or shall it be a single tube with two floors? The single-tube plan is the plan of General Goethals and is favored by many of the New Jersey members of the commission. The twin-tube idea is the proposition of Vipond Davies, and this is favored by some of the New York members. The hope of some is that there may be a happy merger of the two ideas." The happy merger, we must assume, would be two tubes that beat as one. We wait breathlessly the details of the "merger" of these ideas.

A Good Government Salary

SALARIES in the Railroad Administration are good. Monthly wages counted by the thousands are common, and some few fortunates approach the thousand-a-week basis. It is the one branch of Government service where there is an approach to that ideal condition where a man's pay is commensurate with the private reward for the same work. And yet even those of us who have consistently advocated a better Government wage scale are somewhat stunned by the $25,000 a year paid to the Director of Inland Waterways. High cost of living notwithstanding, that is a lot of money for what has been done; it is altogether too much money for a subordinate who can only supervise minor operations under the direction of a none-too-sympathetic administration. Only an independent waterways bureau, which could initiate and carry out a real waterways program, would justify such a salary.

Gambling on Price Reductions

THERE appears in some quarters a tendency among highway contractors to speculate on a drop in material and labor prices. While material prices are in a state of some uncertainty, with chances of small changes in either direction, there is no apparent basis for bidding on the expectation of reduced prices, such as occurred in a recent state highway letting at Albany, N. Y. In some materials, such as cement, assurance has been given that there will be no advance during the calendar year, but the safe interpretation of that assurance is that there will be no decline. In the labor market conditions do not favor lower wages. The labor which has built our roads heretofore is returning to Europe in large number, and an oversupply is not to be looked for. The testimony of many contractors who bid on the New York State work referred to above is that the engineers' estimates for the work were none too high at present prices. And yet these were cut by the low bidders anywhere from 4 to 25%. Surely in the circumstances a word of caution seems in order. It is a big gamble to contract to do work at prices fixed in the hope that the market will decline.

Airplane Mapping

MARKING another of the scientific or technical advances recorded as the result of the great war, airplane photography for producing topographic maps promises many advantages for the future, provided the difficult problems introduced when accuracy is desired can be met. The two articles in this issue are unusually valuable in showing in complete detail just what the present status of this new field is, and presenting clearly the nature of the problems yet to be solved. With our American genius for invention, it is safe to predict that these problems will be solved, and that the production of airplane maps of relatively great accuracy is to be reckoned as a foregone conclusion. Whether the cost will be prohibitive, or so great as to offset entirely the advantages in time saving which are claimed for the methods used, will be a matter for future development. But that there are great possibilities in these methods must be conceded. Their application introduces into a somewhat tedious operation the spirit of adventure.

Half-Section Roads

PERIODICALLY some one suggests the advisability of paving only half the roadway on country highways, leaving the other half soft for the benefit of horse-drawn traffic. In other cases, as proposed in a bill now before the Pennsylvania legislature, soft roads on each side are advocated. Such suggestions generally emanate from those who are interested in livestock, for there can be no doubt that roads of this character are much easier on horses' feet. However, there are constructional disadvantages in these types, and, in the half-section road, there is one feature which tends to make the road dangerous for motor-driven traffic. In this construction it is necessary, on account of drainage, to slope the road away from the center line. Therefore, on curves where the improved strip is on the outside, there is actually a case of reverse banking. Some roads in the East built in this way, notably the Buffalo-Niagara Falls boulevard, are positively dangerous, and have been blamed for many accidents. At the same time reverse banked curves are very uncomfortable for motorists at even moderate speed. Furthermore, the earth side roads are very expensive to maintain, if there is much traffic. The maintenance on the earth section of the Buffalo-Niagara Falls Boulevard, mentioned above, is reported at about $1000 per mile per year.

Where insufficient funds exist to build an entire surface, a combination design may be used as an expedient, with the intention of future widening, but its advisability is doubtful as a permanent improvement.

Wages Reduced In One Industry

FREQUENTLY we hear it stated that it will be impossible henceforth to lower the wage level. Obviously, those who speak in this way do not take the facts into consideration. Wage levels rise and fall with price levels and, in general, it is true that wage levels cannot be materially reduced while the price levels that carried them upward remain at the high mark. Nevertheless, there is a shining example in one of our American industries which shows that wages can be cut in defiance of the high price level. The industry in question is that of copper mining. The signing of the armistice found us overstocked with copper. The condition was one that encouraged the wholesale closing down of mines with the consequent danger of widespread unemployment in the copper-producing districts. Instead of that, the operators elected to keep the mines going at reduced capacity and to retain the forces in as large numbers as possible. With copper, however, selling down to about half its war price, it was obvious that the industry was not in a position to maintain the war wage-scale, and it promptly placed these conditions before the miners. Moreover, when the time came for action the operators did not ruthlessly issue an edict as to the wage reduction, but announced some time in advance the necessity for the change and gave ample time for the miners to digest the situation, to enter their arguments and to offer suggestions. The result was that the miners, appreciating fully the position of the operators, accepted without strikes or any other disturbance the reduced scales, confident that no other course was open to the industry. Many another industry, when the time for wage reductions comes, might take a leaf from the book of the copper producers.

Concealed or Physical Deficit

IN REPORTING to the stockholders of the Delaware & Hudson Co. last week, the president, L. F. Loree, discussed what may be termed the "concealed or physical deficit" as distinguished from the apparent or financial deficit under Federal operation. The financial deficit the Government will make good to the stockholders, for the contracts call, as every reader knows, for a return based on pre-war operation. What of the deficit due to inadequacy of maintenance? Will this be appraised fairly when the Government returns the roads, or will long-drawn-out arguments and legal contests be necessary before this concealed or physical deficit is made good? The Government in taking over the roads gave assurance that the properties would "be maintained during the period of Federal control in as good repair and as complete equipment as when taken over by the Government."

On the Delaware & Hudson system, however, Mr. Loree pointed out, the tie renewals in 1918 were 241,504, as against an average annual tie renewal, during the test period, of 339,575 ties. The deficiency, therefore, was 29%. At the average price per tie in 1918 of $1.12 the deficit in money would be about $110,000. Moreover, the quality of the ties used in 1918 was much below that of the ties used during the test period. At the present time there is in stock not more than 21% of the ties accumulated at corresponding dates in the test period. Somewhat the same condition obtains with reference to rail renewals. They show a deficiency of 28% in tonnage compared with the renewals during the test period, and a deficiency in money of about $102,000. Again, the Railroad Administration has dismantled 131 freight cars and none of them has been replaced, nor does the railroad know the condition of the 90% of its cars used on foreign lines.

Mr. Loree recognized that during the stress of war there were conditions that rendered it difficult to keep the property up to the standards obtaining before Government control, but that does not change the fact that the property is not maintained as the Government agreed to maintain it. Moreover, other properties have been suffering in the same manner.

Obviously, the Government must catch up with this maintenance deficit before the roads are returned to their owners, or must be prepared then to make good the deficit. Any other procedure would be a grave injustice.

Old, Overworked Filter Plants a Serious Health Menace

OBSOLESCENT condition of a water-works and water-purification plant, as in a Middle West town, a condition which is described by a correspondent in the following paragraph, does not occur frequently. Such plants do exist in certain cases, however, and occasionally it takes a typhoid epidemic to jar public opinion sufficiently to force general overhauling. Like a faithful truck horse, the plants need considerate treatment. Quoting the letter:

"The intakes were insufficient as used and one had a serious break about 150 ft. from shore into which drainage from the plant sewer, carrying wash water and mud from the basins, entered. There was only one screen in the raw well to protect the pumps. The low-duty turbine could not draw water through the channel intake—for which purpose it was designed and installed. There was no means whatever of agitating the alum solution made in the tanks, nor means of measuring the raw water to know how much was being treated. No means of measuring or even definitely regulating the flow of the alum solution existed; therefore, it could not be proportioned to the raw water treated. A very short retention period was provided in the settling basins—nominally three hours, but actually some water passed through in less than one hour. Wash water was carried away by troughs badly out of level and leaking to such an extent as to waste much sand. Because of the 3- to 6-in. difference in elevation in the filter bottoms the air wash was almost useless, and dependence had to be placed on wash water which had a vertical rise of only 9½ in., and the very excessive lateral travel of 5 ft. 2 in.

"Is it strange that mud bars a foot wide extended along each filter, and that the bed contained fouled sand like garden soil? The supporting gravel was of all sizes—one filter had only 5 in., none of which was more than ¾ in. in size, while another had pieces of sandstone up to 5-in. size. The controllers were out of order, as were also the loss-of-head gages.

"The chlorine machine was more than ready for the

scrap heap. There was not only no means of measuring the chlorine applied, but also there was no means of knowing how much water was being filtered, so that the treatment was of the most hazardous kind. The amount of chlorine that the machine could deliver was very limited, and we were often seriously gassed trying to speed it up.

"The filtered water reserve was absolutely inadequate, the domestic demands alone often exceeding the plant capacity plus the storage. If there had been a serious fire at such a time and the bypass could not furnish enough, the pumping-station engineer would have opened a valve allowing the high-duty pumps to take their suction directly from the raw well, and not a bit of chlorine could have been used on this water. The high-duty pumps were in need of many repairs. A booster booklet spoke of this plant as being able to deliver 21,000,000 gal. daily, but how could the filter plant produce even its rated 5,000,000 gallons?"

Many of the construction features in this filter plant were standard practice much less than 20 years ago. Modern sterilization methods have added years of life to these old filters, but it is unfair to expect a plant with crude and wornout apparatus to carry a normal burden. Stream pollution all over the country is steadily on the increase, so that the intervals between infections grow less and less. Plants which were good enough, even excellent, 10 years ago may be dangerous today, for the germs of disease are many times more prevalent in the raw supply. Standards must be higher, laboratory control more rigid, expert advice sought—and followed—more frequently. With the war over, it behooves city officials who have any doubt at all of the integrity of their supply to look into it most seriously before the blood of typhoid victims is upon their heads.

Riveted-Truss Span of Record Length

ALTHOUGH the primary reason for the adoption of riveted joints in the new 644-ft. span of the Pennsylvania Railroad's Ohio River birdge at Louisville, Ky., described on another page of this issue, was the necessity for unity throughout the structure, yet the use of a stiff riveted type is consistent with the practice of Pennsylvania Lines West of Pittsburgh during the past twenty years. This preference is based not alone upon the desire for greater rigidity, but also upon the feeling that the eye-bar type has certain disadvantages, especially in the fact that all bars in a given member do not obtain equal stress, and that unavoidable wear takes place at the pins.

The new 644-ft. span, the length of which resulted from the Government requirement of a 600-ft. clear channel and the desire to utilize the masonry piers of the old bridge, is not only the longest and heaviest simple riveted-truss span in existence, but it is third among the world's simple-truss spans, being exceeded only by the 721-ft. Metropolis span and the 668-ft. St. Louis municipal bridge span, both pin-connected. It is about 4 ft. longer than the 640-ft. suspended span of the Quebec bridge. The next in span length of the simple-truss type is the 620-ft. bridge of the Kentucky & Indiana Terminal R.R., also located at Louisville. All of these American bridges exceed in length the longest simple-truss span in Europe—610½-ft. Homberg span of the Prussian State Ry. over the Rhine at Homberg.

The new span is built of high-carbon steel rather than alloy steel because of the designer's objection to the use of high unit stresses on the score of excessive deflection and a resulting tendency to rack the floor system. Double floor-beams at each panel point, making the stringers discontinuous, not only facilitate erection in panel units, but also reduce the danger of loose rivets in the floor system. Although a high-carbon steel was specified, the unit stress was not increased, the margin being considered necessary to allow for secondary stresses, which were not computed.

One cause of the exceptional weight of the new span lies in heavy details. For example, all compression chord splices, although milled to bear, were fully spliced by providing splice plates and sufficient rivets to take the full stress. Transverse diaphragms for all members, spaced at relatively frequent intervals, and longitudinal diaphragms at the ends of diagonal members to insure stiffness and exact dimensions, also increased the weight, but at the same time were found to facilitate field assembly and aided greatly in keeping the long members in true shape and out of wind. Heavy gusset plates, required by the exceptionally large number of field rivets, taxed the capacity of the rolling mills. For example the 130 x 1½-in. plates at the hip joints are the maximum attainable.

An exceptional feature in the design of this bridge was the adoption of a live load consisting of a uniform train load combined with a single concentration. The reason for the preference of this loading lies in the designer's claim that Cooper's standards do not really represent actual engine loadings, especially for heavier locomotives, which do not have axle concentrations of equal value, nor is the actual wheel spacing the same as that given by Cooper's standards. Experiments which have been made by weighing the main drivers of such locomotives indicate that the actual loads on the main driver axles vary quite widely.

Certain features of the design are noteworthy. For example, the lower chords are built up with a constant base section composed of vertical webs, eight angles and four narrow horizontal longitudinal plates placed at about the third points vertically and laced together. Outside and inside vertical web plates provide the additional areas required for the heavier chords near the center. The top-chord section is composed of eight angles instead of the usual four angles for lighter trusses. This made necessary the splicing of gusset plates at the joints, these gussets being inserted in the plane of the main web plates—a detail similar to that used in the 525-ft. Ohio connecting bridge at Pittsburgh, on the same road.

The replacement of this historic structure, with its long series of Fink-truss spans, by new double-track trusses of exceptional weight, is another example of the changes forced by the constant increase in locomotive loading. The old trusses, with reinforcement, long and faithfully served their time, but finally had to be abandoned. The difficult problems of erection under traffic, which will be described in a later issue, were successfully solved, and the new steel superstructure, one mile long, now stands as the latest example of heavy riveted-truss design—with its channel span of record length, its series of heavy deck trusses, a through span 370 ft. long and a 260-ft. lift span with the latest improvements.

Present Status of Photographic Mapping From the Air

Airplane Mapping Possible and Practicable, but Two Great Problems, Horizontalization of Camera and Effects of Surface Relief, Must Be Solved

By J. B. Mertie, Jr.
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New developments in the application of photography to the making of topographic maps have resulted directly from the experiences of the war. Mr. Mertie's appraisal of the present situation in aëro-photography and his clear-cut analysis of the difficult problems which remain to be solved are the result of first-hand contact with the airplane mapping investigations carried on by the Survey in coöperation with the United States Engineer Corps. This article is followed by a detailed description of the successful Bagley camera and of the transforming camera developed by F. H. Moffit and the author. Additional information on photo-topographic methods and on the use of air-photographs in the war will be found in the article on "Stereophotographic Surveying" by Otto Lemberger in "Engineering News" of Mar. 27, 1913, p. 602, and in the description by R. K. Tomlin, Jr., in "Engineering News-Record" of May 23, 1918, p. 984, of the work of the Army topographical division in coördinating the work of the mapmakers in the air and on the ground.

Mr. Mertie's paper is published with the permission of the Director of the United States Geological Survey—Editor.

A STEADY demand exists at the present time for information regarding the possibilities and methods of photo-aërial mapping. The Geological Survey is continually receiving requests from individuals, commercial organizations, and even from foreign surveying corps, for information concerning what has been accomplished to date and what developments may reasonably be expected in the near future. The writer, having been associated in the airplane mapping investigations carried on by the Geological Survey in coöperation with the United States Engineer Corps, is reasonably conversant with the present status of airplane mapping, and undertakes herewith to set forth a short summary of results so far achieved, with the twofold intention of furnishing information to those who may be interested, and of correcting a number of erroneous impressions which appear to have been disseminated by ill-conceived and misleading publications on the subject.

Airplane mapping by means of photography is possible and practicable, but has by no means yet been developed to the point where it may be described as a smoothly working process. Problems of the first magnitude remain to be solved before the airplane camera can take the place of the plane table and alidade, and in the author's opinion it is much better to face honestly the difficulties than to gloss them over and optimistically set forth the airplane mapping method as a surveying panacea.

A number of articles have appeared recently which either from ignorance, unbalanced optimism, or from utter disregard of the facts, have described the process of airplane photographic mapping as a finished product, capable of being taken up by an organization and utilized as a complete substitute for the older methods of mapping. Such publications, in their unwarranted advertising of a method as yet imperfect, are most apt to do harm, in the same way that worthy mining enterprises have suffered from the promotion of stock-selling mining swindles. It is certainly to be hoped that a process so full of promise as the one under discussion may be spared the fate of passing through a miasma of temporary failure, with the consequent doubt and controversy, due to premature and unwise schemes of promotion.

Principles of Photographic Surveying—Two Problems

Photographic surveying on the ground has been known and practiced for many years in many countries, including the United States and Canada. A tremendous amount of work has been accomplished in this subject, and the underlying principles are thoroughly worked out and understood. With the advent of the dirigible balloon, however, and later the airplane, a new application of the method was seen and the possibilities of the aërial survey came to be recognized. It is not the purpose of the writer in this article to describe in detail the technique of the subject, but it may not be out of place to state that a photograph of a plane and horizontal surface taken from the air upon a photographic emulsion held parallel to the plane of the horizon is a true map. The lens has acted merely as a point of projection connecting one plane with another, and of course the scale is dependent both on the distance of the lens from the ground and on the distance of the photographic plate or film from the lens.

Any relief upon the surface of the object photographed, however, or any inclination between the plane of the ground and the plane of the plate or film, vitiates at once the results and necessitates the making of compensating corrections. As a matter of fact, the surface of the earth shows everywhere more or less relief, and also in actual practice it has not yet been possible to hold an airplane camera in a truly vertical position. Hence both causes of error are present, and both must be recognized and corrected. To emphasize these facts and to point out a line of progress for the correction of these causes of error is the writer's purpose.

Before passing to the more fundamental problems, a few words concerning cameras may not be amiss. A large variety of aërial cameras has been designed and manufactured, both in this country and abroad, and it is safe to say that none is truly universal in scope. Nor should the cameras be. They have been made to fulfill a variety of purposes, including scout photography along the battle line, more accurate and adequate photography from larger battleplanes, surveying cameras for peace times, cameras for pictorial aërial photography, and others. There have been automatic and nonautomatic types, equipped with various lenses and various types of shutters, and made to take plates or films or both. Also multi-lens cameras have been built, of which the first was probably the eight-lens camera built by Scheimpflug, the Austrian Army officer, and developed by himself and others. A modification

of this type is the three-lens camera, designed by J. W. Bagley of the Geological Survey, now Major Bagley of the Army Engineers.

Mere Mosaics Are Not True Maps

Coming to the subject of aërial mapmaking itself, one is confronted with much confusion of ideas. It has been the practice of some workers to take a series of pictures from the air, fit them together into a photographic mosaic, ignoring the two sources of error previously mentioned, and to call the resulting product a map, or a mosaic map. In truth, it is neither, but only a series of pictures showing distortion, differences of scale within the individual picture as well as between them, and lack of geodetic control, which are fitted and fudged together to present a pleasing appearance. This certainly is far from being a map. Others have gone somewhat further, and by means of a plain enlarging camera have corrected as far as possible the differences in scale, and also by means of a swing-back attachment on the enlarging camera have attempted, though unsuccessfully, to eliminate distortion. Such pictures, when taken over an area which has been covered previously by an accurate ground survey, may be laid out over a network of close control, and fitted together to look moderately well. But this also falls far short of aërial mapmaking, for the results are inaccurate at best, as may be proved by superimposing a transparent tissue showing the true map; nor would such mosaics be convincing even if the two images are made to coincide, for the same results could not be accomplished over an unsurveyed and uncontrolled area. It is quite safe to state that a true aërial map has not yet been made or published in the United States, using the term "map" with the connotation of accuracy usually understood by experienced cartographers. This statement is made advisedly and with full understanding of what has been accomplished up to the present time.

It does not follow, however, that such mosaics are useless, for, on the contrary, there are many ways in which they can be profitably used. Thus, in revising and bringing up to date old maps, or for securing timber culture or other visible data in previously surveyed areas, there is a distinct and useful field for them. Likewise, in the production of route charts for flying, where the need is for a small-scale guide rather than an accurate map, they can be used to advantage. Also, they may be used as an accessory to traversing, in an area where ground control is close enough that the ever-present errors may be recognized and distributed. These are all peace-times uses and take no cognizance of such additional uses that mosaics may have on the battlefield. The point that is made and emphasized, however, is that a mosaic composed of distorted photographs is not a map, and should not be represented as such.

Let us now turn to the map such as would be desired by any surveying corps, or by any commercial or real estate firm, or by any other organization that would ordinarily secure the desired results by instrumental ground surveys. Maps are of different kinds and are made in various scales and with different degrees of accuracy. Thus, there are recognized exploratory, reconnaissance, detail and ultradetail maps, ranging from scales of 1: 1,000,000 or smaller up to an extremely large scale, and on, still farther, to natural-scale maps, or even maps that are magnifications of the objects shown. Also, there are plan maps and relief maps, the former showing natural and cultural features and the latter indicating, by means of hachures, contour lines or other means, the regional relief. Likewise, there are timber maps, geologic maps, soil maps, and other special kinds. The most generally useful map is the modern topographic map, as now produced by the Geological Survey, which shows all natural and cultural features, including also timber areas, and indicates also by means of contour lines the relief of the terrain. The production of such maps, at scales of from 1: 250,000 up to 1: 62,500 is the present aim of most workers from the air.

Modern Topographic Maps—Stabilizing Camera

The modern topographic map presupposes an accurate plan map upon which the contour lines may be drawn. It is possible to derive both the plan and the contour lines from aërial pictures, provided the necessary data are given, but it is impossible to make either of them from uncontrolled pictures fitted together in mosaic form. Let us consider first the plan map, since that is all that has been attempted in the United States to date.

As before stated, no method has as yet been found to hold in a vertical position a camera in a moving airplane. Various methods have been tried, and none has been found to give the desired degree of accuracy, though of course some schemes reduce very materially the deviation from the vertical. One method has been to mount the camera in gimbal rings, and by the use of dash-pots to give the camera the movement of a damped pendulum. The centrifugal force caused by movements of the plane, however, is sufficiently great to cause a pronounced deviation from the vertical; and, in general, it may be stated that any device dependent wholly on the action of gravity is vulnerable in this respect. The writer, in association with Lieutenant Hyde, of the United States Air Service, and F. H. Moffit, of the Geological Survey, has recently tried out such an arrangement controlled by a gyroscope; in effect, a camera mounted as a gyro-pendulum. The result of this work has been decidedly encouraging, and shows that the gyroscope is a most useful accessory. The deviation, however, is still much too great to permit the production of uniformly good register between adjoining negatives. The results of measurements on such prints, so far as the work has been carried at the present time, shows deviations from the vertical ranging up to 2°. It should be mentioned, however, that these results were secured in flying with a J N-4-type Curtiss airplane, and it is likely that the same apparatus if tried out with a more stable type of machine would show smaller deviations.

In this connection it is also worth while to note that it is the maximum and not the mean deviation which concerns the mapmaker, for if one or two pictures are distorted beyond any assigned limit, the control is vitiated. The old proverb that a chain cannot be made stronger than its weakest link is well illustrated in the case of aërial pictures which are intended for map construction. Therefore, if stabilization of the camera itself is the goal in view, it remains to construct a more refined instrument that the one above noted, for a maximum deviation of 2° is much too great. A maximum deviation of ¼° from the vertical position is probably closer to the desired result. Yet it must not be overlooked that a gyro-pendulous camera, even at the pres-

ent stage of development, can be used to good advantage as an instrument for traversing, where control points are not too far apart. The errors resulting from tilt may then be distributed and the resulting traverse will be far more detailed and probably more accurate than the usual result gained by ground traversing. Also, mosaics built from such pictures will of course have a greater value than those made from negatives taken without the gyroscope attachment.

An Alternative—Stabilized Reference Point

Another alternative, however, exists than that of complete stabilization of the airplane camera. If each picture can be referred to a stabilized point, so that the tilt of the negative and the direction of the tilt may be ascertained, such data will be sufficient, with the aid of the necessary instruments and procedure, to rectify the negative to the plane of the horizon. This method of attack involves the construction of some piece of apparatus which will maintain a stabilized reference-point during the flight of the airplane; and accessory lenses, mirrors or prisms, together with a synchronizing device which will record the position of this point relative to the film or plate at the moment when each exposure is made. The gyroscope naturally occurs as the means of attaining such a stationary reference-point, and it is believed that this method is perhaps as promising as any. A gyroscope used in this manner will differ from one used in a stabilized camera in that it will have less work to do and can therefore be made lighter and more compact, and the accessory apparatus can also be constructed at a relatively low cost. Taking into account the present state of development of gyroscopic apparatus, and the limitations of the gyroscope itself, it would appear that this method gives promise of a degree of accuracy surpassing that of a stabilized camera.

The sun, being a fixed point in the heavens at any given time on any given day, also suggests itself as a solution of the difficulty. Any apparatus utilizing the sun's shadow, however, has three serious limitations: First, flying could only be done on cloudless days; second, a difficulty will arise in so placing the recording apparatus that it will never be in a shadow cast by any part of the airplane. This involves placing the device at some distance from the camera, whose natural place is in the bottom of the fuselage, and such a separation is likely to cause errors, due partly to lack of close adjustment originally between two separated pieces of apparatus and partly to differential movements due to lack of rigidity of the plane in motion. The third objection is the most serious. A little experimentation by anyone interested in the matter will show that although the sun's shadow will record the degree of tilt of the camera, it will not indicate the direction of such tilt, and it is just as necessary to know the latter as the former. A compass would have to be used to obviate this difficulty, and air compasses are notoriously inaccurate, when by accuracy one refers to the registry of fractions of a degree. Application of the gyroscope, therefore, to this problem appears to hold forth the greater promise of success.

Let us suppose that the amount and direction of tilt are known for each picture. How are these inclined negatives to be transformed to the plane of the horizon; or, in other words, how can orthographic projections be made from them? Reference has already been made to the successful attempts by some workers to attain this result by means of an enlarging camera, equipped with a swing-back. A simple geometrical demonstration is sufficient to prove that rectification to the plane of the horizon by such a method is not possible. The only practicable way in which this result can be achieved by photographic precedure is in a specially designed transforming camera; and the condition that must be met, in order that such transformation should be geometrically possible, is that the plane of the negative, the plane of the transforming lens and the plane of the transformed image meet in a common line in space. A further adjustment is necessary in order that the lens may be properly placed with reference to the line of intersection of the negative and image planes. Transforming cameras built with the necessary movements and adjustments, and constructed as instruments of precision, have been designed by F. H. Moffit, of the Geological Survey, and have been built and successfully used by the Geological Survey and the United States Engineer Corps. This problem of the transformation of inclined negatives to orthographic projections, or of the transformation of negatives from any one plane to any other, may be therefore considered as solved. A paper by F. H. Moffit, presented before the Association of American Geographers, describes the theory, construction, and use of the transforming camera. [This paper is reproduced immediately following this article.—Editor.]

Using Three-point Method

An interesting development which has been recognized in the use of the transforming camera is the possibility of horizontalizing, by a method of trial and error, a negative whose tilt and direction of tilt are unknown, provided the true positions of any three points on the negative are already known. This presupposes, of course, that an accurate and detailed horizontal control has already been established, and that three points in favorable positions can be recognized on each negative. Under such conditions an accurate map can be made, but, as before stated, this is only of academic interest, for the same result could not be duplicated over an unsurveyed area.

Merely to show the geometrical possibility of this procedure, however, F. H. Moffit, assisted by the writer and T. P. Pendleton, of the Geological Survey, constructed during the summer of 1918 a map of a portion of the City of Washington, by this method, using negatives made with the Bagley camera. [See the article which follows.] No corrections, however, were made for relief, and the result is therefore not a true map in the strict sense of that term, but it is believed to be a very close approximation to one. The writer sees one important application of this method. If, for any reason, the control is lacking in some one picture in a set of air negatives, three points may be selected which will show in the overlap with the adjoining horizontalized negative, and the uncontrolled negative may thereby be rectified with less difficulty than would be involved in a mathematical determination of the unknown tilt.

A brief reference to the matter of scale is also in order. It is very hard, even with the best type of instrument for recording altitude, for the pilot to hold a plane at any given elevation. Anyone who has done any flying where the air is "bumpy" will realize the difficulty. If one is flying or trying to fly at an elevation of 5000

ft. a rise or fall of 100 ft. means at once a change of 2% in the scale, perhaps in two adjoining pictures. In making mosaics, when the distortion due to tilt has not been eliminated, this is a very vexing condition, for the tilt itself, in addition to causing distortion, produces also differences in scale throughout any one picture; that is, the scale along a line at one side of a picture will be different from that along a line at the opposite side, and of an unknown magnitude. To attempt to correct by enlargement or reduction, under these conditions, is to undertake the impossible. But when the negative is horizontalized differential changes of scale are automatically eliminated. Hence, for horizontalized negatives, change of scale is met by simple enlargement or reduction in a plain enlarging camera. It is worth while, of course, to study the matter of flying as nearly as possible at a given elevation in order to reduce the labor of enlargement or reduction; but, relative to the other problems involved, the question of scale is a rather minor one, when dealing with horizontalized pictures.

Corrections for Relief

And now, how close are we to a topographic or even a plan map, after complete horizontalization is achieved and after all the pictures are reduced to the same scale? In regions of very low relief, such as our coastal plain areas, the result is a very close approximation to an accurate plan map. But if the pictures were taken in a region of moderate or greater relief the result is not a true plan map, because of distortion caused by the relief itself. This fact is too apparent to need any elaboration, but it is by no means an insuperable difficulty. Methods must be perfected, however, for the application of the necessary corrections, before the true map can be realized. To make this correction involves the determination, either mathematically or graphically, of station points of the camera in the air at the moment of successive exposures, and this can be accomplished by a study of the common points of two horizontalized pictures taken from two different stations. The same comparisons and computations are also necessary in working out contour lines in the making of a topographic map from air pictures. Hence it follows that the making of a true plan map in an area of any considerable relief is intimately bound up with the problem of the construction of topographic contours, and the solution of one of these questions brings also the solution of the other.

One promising method for the achievement of the desired result appears to be in the application of stereophotogrammetry, particularly by the use of the stereocomparator. This instrument affords an accurate and elegant solution of the problem, although, of course, the same results may also be obtained by other methods.

Finally, with regard to photo-topographic surveying in general, certain facts should be more generally recognized. In the first place, the making of topographic maps is a specialized science, and is a subject which is not mastered except by prolonged practice. Photo-topography is only a phase of the general science of cartography, and the cumulative results of long experience are just as valuable in photo-topographic mapping as in any other method. The laying out of projections, the subject of triangulation and control, with the consequent computations, the theory and practice of adjustments, and other matters familiar to the topographic engineer, are equally applicable and necessary in photographic surveying. In other words, the making of maps by photography or by any other method should be the work of experienced engineers.

Photographic Practice Subordinate

Correlative with this idea is the other that photographic practice is rather of subordinate importance. By this, the writer does not mean that the photo-topographer should neglect the photographic side of his work, for good pictures are most desirable, though the quality of the map is not necessarily dependent on the securing of perfect negatives. The idea to be emphasized, however, is that the finest pictures may be entirely useless unless accompanied by the necessary engineering data; while, on the other hand, poor pictures if properly controlled may make a perfect map. The experienced photo-topographer attempts to get the best pictures possible, but judges his work by the quality of the finished map and not by the pictorial quality of the pictures from which the map is made.

Summarizing, it may be said that photographic surveying from the air is both possible and practicable. No new principles are involved, but methods and apparatus other than those used in photographic surveying on the ground are needed and are gradually being studied out and developed. It has been shown that the production of an accurate plan map in an area of any considerable relief is intimately connected with the production of the much desired contour map, and that the latter will be produced with little more labor than the former. In areas of low relief, of course, the plan map can be produced as soon as perfect horizontalization becomes an accomplished fact.

The crux of the whole problem lies in horizontalization, and the most pressing need of the present moment is either a completely stabilized airplane camera or a successful attachment which will record the direction and amount that the camera deviates from the true vertical. Also, it should be clearly understood that map-making is an engineer's job, and that pretty pictures do not necessarily make the perfect map. Finally, although maps made by air surveys remain a development of the future, yet we may confidently look forward to an early solution of the various problems involved.

New Road Work Records Made in April

During April, 1919, the Secretary of Agriculture approved project statements for 120 Federal-aid projects, involving the improvement of 923.53 miles of road, at a total estimated cost of $16,261,326.51. On these roads Federal aid amounting to $7,528,550.68 was requested. This represents the largest number of project statements approved, the largest total estimated cost, and the greatest amount of Federal aid requested, during any month since the passage of the Federal-aid road act. The Secretary and the several state highway departments executed 55 project agreements, involving the improvement of 521.51 miles of road, at a total estimated cost of $4,626,415.48, and on which $2,039,614.99 Federal aid was requested and set aside in the United States Treasury. In addition, agreements to cover 72 other projects were placed in process of execution during the month.

Methods Used in Aëro-Photographic Mapping

Outgrowth of Experience in Use of Panoramic Camera in Alaska—Application to Problems of Airplane Photography—Theory of Transforming Camera

This article, published with the permission of the Director of the United States Geological Survey, is a reproduction, practically in full, of a paper by F. H. Moffit, in the "Geographical Review." Mr. Moffit describes in detail the Bagley camera, referred to by Mr. Mertie in the preceding article, and the theory underlying the transforming camera.—EDITOR.

THIS is not intended to be the description of a finished piece of work, but rather a report of progress in the development of a method of mapping which is only in a formative stage. It will not do, therefore, to expect that details will be given with the greatest accuracy and that all the problems connected with the work have been solved, although the general principles on which the method is based are fully established. The direction for progress has been pointed out, but many steps remain to be taken.

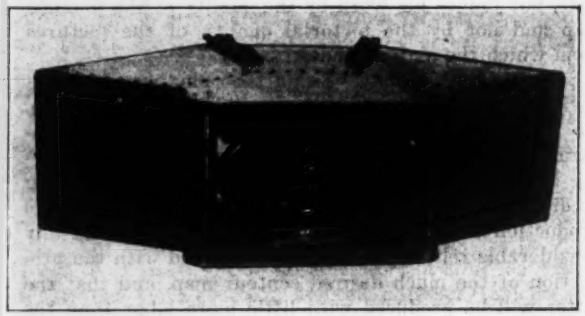

FIG. 1. BOTTOM OF AIRPLANE CAMERA SHOWING THE LENSES AND THE SYNCHRONIZING DEVICE

The work to be described is the outgrowth of experience in using the panoramic camera for topographic mapping in Alaska during the past eight years. The panoramic camera was first used in the Alaskan work of the Geological Survey by C. W. Wright in 1904, but it was not until after he had left the Survey and his work was taken over by J. W. Bagley, now Major Bagley, that the panoramic camera became one of the instruments regularly used for topographic mapping in Alaska. The opportunity to take up and carry on this method was due primarily to Mr. Brooks, now Lieutenant Colonel Brooks, chief of the Alaska division.

With the outbreak of the great war in Europe and the rapid development of the airplane for military purposes, the camera immediately took an important place as a means for gathering military information, including the making of maps. Major Bagley turned his attention to this broader field for the camera and asked the writer, who had had some small part in the previous work, to assist him, but as progress was made it was found that more assistance was needed, particularly in photography, but also in many other ways, and J. B. Mertie was invited to contribute the benefit of his experience.

These investigations, which at first were carried on under the direction of the Council of National Defense and Mr. Brooks of the Alaskan division of the Geological Survey, were later taken over by the Corps of Engineers of the Army and Lieutenant Colonel Marshall of the topographic branch of the Survey, where they have remained to the present time. Money for the first experiments was furnished by the Council of National Defense, but the large sum needed for the construction of airplane cameras and transforming cameras was allotted by the Engineer Corps. I take this opportunity to express to Colonel Marshall, under whose immediate direction I have worked during the past year, my appreciation of his enthusiasm and the generous encouragement he has given Major Bagley and myself.

The fundamental principle on which our investigations is based was first expressed, so far as my knowledge goes, by Capt. Theodore Scheimpflug, an Austrian Army engineer, who gave many years of his life to the study of the problem. He, however, lived before the days of the airplane, and his methods did not meet with the full success they deserved, so that he died without seeing any extensive application of them.

If a camera is carried above a horizontal plane and an exposure is made with the sensitive plate parallel to the plane, the resulting picture is a map whose scale is dependent on the focal length of the lens and the height of the camera above the plane. We apparently have at hand, then, a simpler way for making maps of many regions than the way ordinarily employed, for the airplane makes it possible to pass back and forth over a chosen area at will. Yet two difficulties are met when airplane photographs are employed in making maps. First, it is impracticable if not impossible with any means yet devised to keep the camera in a horizontal position; second, the angle of view of the fast lenses which must be employed in taking photographs from airplanes is small, as that the area covered at each exposure is also small and a great number of pictures must be taken in constructing the map. These, then, are the first problems that must be taken up if an accurate map is to be made at less expense than by the usual surveying methods.

The investigation to be described falls naturally into two divisions, of which the first deals with the airplane camera—that is, with photographing the terrain. To this Major Bagley gave his attention. The second has to do with correcting the inclined airplane pictures, and for the study of the principles involved and the design of the transforming camera the writer is responsible. The questions relating to photographic methods and the construction of charts and computing devices

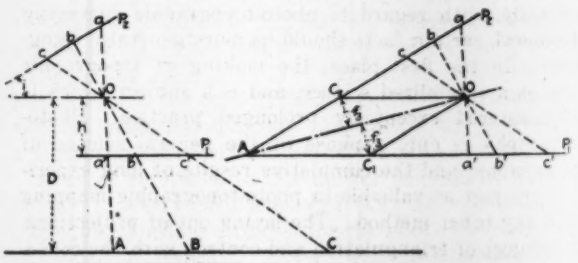

FIG. 2. PRINCIPLE OF CONSTRUCTION OF THE TRANSFORMING CAMERA

for use with the transforming camera fell to Mr. Merrie.

The Airplane Camera—The difficulty of obtaining a lens which shall have speed and at the same time a wide angle of view is met by constructing a multiple camera with its three lenses and focal planes so arranged that the central plane shall be in a horizontal position and the other two shall be inclined at a fixed angle to it.

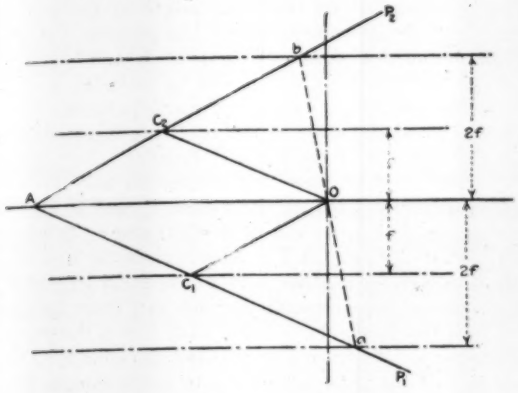

FIG. 3. THE CONDITION FOR FOCUS IN THE TRANSFORMING CAMERA

The side pictures, because of their inclination, include areas outside the field of the central picture, but overlap it slightly so as to give the means of joining them. A photograph of such a camera is shown in Fig. 1.

The camera is about 25 in. high, 22 in. wide, and 7 in. thick from front to back. It consists of two parts, which may be separated from each other. The upper part is the magazine which carries the roll film. The lower part is really three distinct camera boxes, each fitted with its own lens and shutter, joined together.

The two side-focal planes of the camera are inclined to the central plane at an angle of 35°, and as a consequence the angle between the axes of the two side lenses and the central lens is the same. Lenses of about 7-in. focal length are used on the two side boxes and one of about 6 in. on the central box. The automatic shutters, Fig. 1, are released by a special cable release which acts on the triggers of the shutters through a synchronizing device shown in the photograph. This release is so adjusted that the shutters open and close at exactly the same instant. It is necessary that the time of exposure shall be as short as possible, in order that a sharp image may be obtained. This necessity is the result of several causes, chief of which are the vibration of the engine and the angular movement or roll of the plane.

When a film is to be inserted in the camera the magazine is lifted off the boxes, the unexposed spool is placed in position in its supports near the center of the magazine, and the free end is attached to the winding spool in the top of the magazine. After being replaced the magazine is made fast to the lower part of thumb-screws which bring the two sides close together and prevent the entrance of light. The film is 5 in. wide and has a maximum length of about 400 ft. The individual negatives are 5 in. wide and 6 in. long. It was found that pictures taken on the Eastman Company's ordinary "noncurling" film are not marred by static, which so frequently injures airplane photographs, although pictures taken in this camera on other kinds of film, made specially for airplane work, have shown this defect.

Mounting the Camera—To mount the camera in the airplane a hole is cut in the bottom of the fuselage in front of the observer's seat, and a cradle, closed below by a sliding door for the protection of the lenses, is fastened securely to the floor. This cradle is padded with felt or sponge rubber, and the camera is strapped securely in it. Some airplane cameras are mounted on gimbal rings whose movement is damped by a dash-pot arrangement. Such a mounting has been constructed for this camera, but has not yet been tried out. It is not expected that this mounting will keep the camera in its proper position, for seemingly no device dependent on gravity alone for its effect has been able to do this fully. Probably it can do no more than reduce the errors of deviation.

The frequency with which exposures are made at a given altitude in getting pictures with proper overlap depends on the rate of movement of the plane over the ground, which in turn is dependent first on the airplane itself and second on the movement of the surrounding air, for the speed of the plane referred to the ground may be greatly increased or retarded as the plane flies with or against the wind. The time interval between exposures varies roughly from ½ min. to 1 min. The observer making the exposures, however, does not rely on a time interval for getting properly spaced pictures, but is chiefly dependent on a large negative lens about 6 in. square which is set in the bottom of the fuselage and enables him, as he views objects below him, to judge both the direction and the rate of movement over the terrain.

This camera still lacks one essential feature necessary to make it fill its purpose fully. It should have incorporated in it a device for recording on the film at the time of exposure the amount and the direction of the tilt of the central plate, for, as has been stated, it is not yet possible to keep the camera in a horizontal position. Correction of this fault appears to be only a matter of adapting to the camera some such principle as that of the gyroscope on which others have been at work and which seems now to be brought to condition for practical application.

Principles of Transforming Camera—Pictures taken with the airplane camera just described are subject to

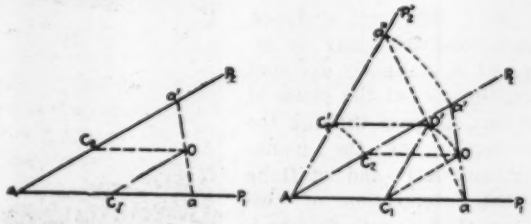

FIG. 4. PRINCIPLE IN APPLICATION OF THE TRANSFORMING CAMERA TO THE RECTIFICATION OF INCLINED PHOTOGRAPHS

errors arising from the construction of the camera itself and from the tilt of the airplane, for only when the plate is taken in a horizontal position is the resulting picture a map. These errors may be corrected graphically by projecting chosen points one by one on a plane representing the plane of the horizon, but the process is long and tedious. It was for the purpose of making these projections photographically that the transforming

camera was designed. Before the working of the transforming camera is described it will be desirable to state two principles on which the construction of the instrument is based. Let A P_1 and A P_2, Fig. 2, be two planes intersecting in the line A, and through any point O pass planes C_2O and C_1O parallel to planes A P_1 and A P_2,

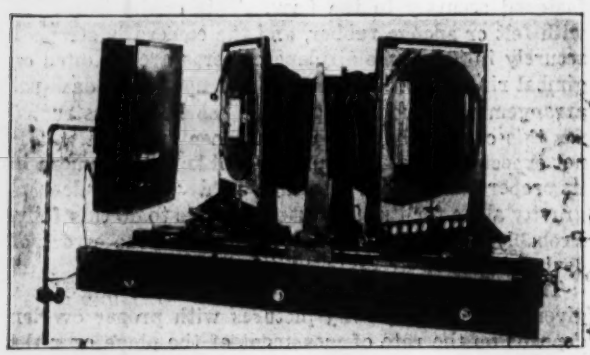

FIG. 5. TRANSFORMING CAMERA, WITH REVOLVING DISKS CARRYING NEGATIVE AND PLATEHOLDER

respectively. Project point a, through point O onto the plane A P_2 in a′.

Now, if we revolve the plane A P_2 about line A, the point a′ is revolved to a″, the point C_2 to C'_2, and O to O′, and it may be demonstrated that the points a, O′, and a″ lie on the same straight line; that is, O′ remains the center of projection for point a and its projection a″ on the revolved plane A P'_2. This principle has an important use in the construction of the transforming camera.

The second principle deals with lenses. Let O, Fig. 3, be a lens of focal length *f*, whose axis is perpendicular to the plane passing through the optical center of the lens and the intersection of two planes A P_1 and A P_2; and further let O be so situated that it lies on the line which joins a, the intersection of A P_1 with a plane parallel to the focal planes, whose distance from O is twice the focal length, to b, the intersection of A P_2 with a plane whose distance from O is also equal to twice the focal distance. These conditions may be expressed in a slightly different way, thus: Let the plane of the lens, O, pass through the intersection of the planes A P_1 and A P_2 and let O lie in the intersection of two planes, C_1 O and C_2 O, which are parallel respectively to A P_2 and A P_1 and pass through the intersections of planes A P_1 and A P_2 with the focal planes of the camera. If these two conditions are satisfied it may be proved that all points on either plane A P_1 or A P_2 are sharply in focus on the other plane. This fact is the second principle which we need to use. Let us now see how these principles are applied to the correction of pictures taken in an inclined position.

Let P_2, Fig. 4, be a negative on which are photographed the points A, B and C. Let f_1 be the focal length of the lens, *i* the angle of inclination of the plate, and *D* the height of the camera above the ground. Points a, b and c are images of the points A, B and C. Now, the size of the image a, b, c (with any given inclination, *i*,) depends on the focal length of the lens and the height of the camera above the ground. This inclined photograph does not show a, b and c in their true relative positions but it can be made to do so by projecting the image onto some plane parallel to A B, such as P_1 and the scale of the resulting image depends on *h*, the distance of the plane P_1 from O.

In order to show how this projection may be made photographically, produce the planes P_1 and P_2 till they intersect in A, Fig. 4, and draw C_1 O and C_2 O through O parallel to A P_1 and A P_2. Also replace the lens of the taking camera by another lens whose focal length is f_2, the length of the perpendicular let fall from either C_1 or C_2 to A′O. It should be noted that A O is the plane of the new lens. We have now fulfilled the conditions that must be fulfilled if we are to obtain sharp images of the points a, b and c on the plane P_1, but we have limited ourselves to the use of one lens in making any given projection and will require a different lens for every different angle of inclination. If, however, we revolve plane P_2 about the axis A we may vary the distance f_2 and thus, within certain limits, adapt our figure to whatever lens we find is convenient to use in the transforming camera. In the description so far the separation of the principal points of the lens has been disregarded. This was done to simplify the description and is entirely proper, for the same conclusions would have been

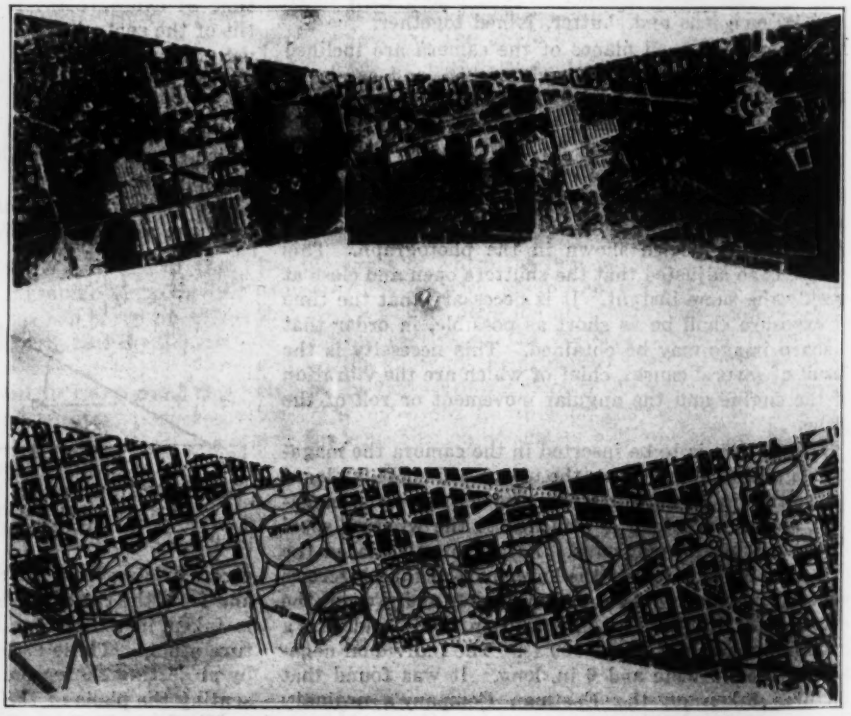

FIG. 6. SET OF THREE PICTURES COMPARED WITH PART OF MAP OF WASHINGTON
The Mall connecting the Capitol, on the right, with the Washington Monument, near the center of the picture, and other prominent landmarks, are easily distinguished.

reached had this been taken into consideration.

The Transforming Camera—The simplest form of transforming a camera capable of transforming photographs taken at different angles of inclination is one in which the two sides are hinged together and have their line of intersections in the plane of the lens. Such a camera is impracticable if the angle of inclination is small or has a wide range of values. The form of camera we have been using is shown in Fig. 5. The two sides, instead of being hinged together, are made to revolve about vertical axes and, together with the lens, are capable of movements that permit all the conditions indicated in the previous diagram to be satisfied. The vertical axes may be moved to and from the lens, and in addition one axis and the lens may be moved transversely. The two axes are so connected with the frame supporting the lens that they and the lens are always in line. The large disks supporting the negative and the sensitive plate may be revolved or they may be moved horizontally in their own planes.

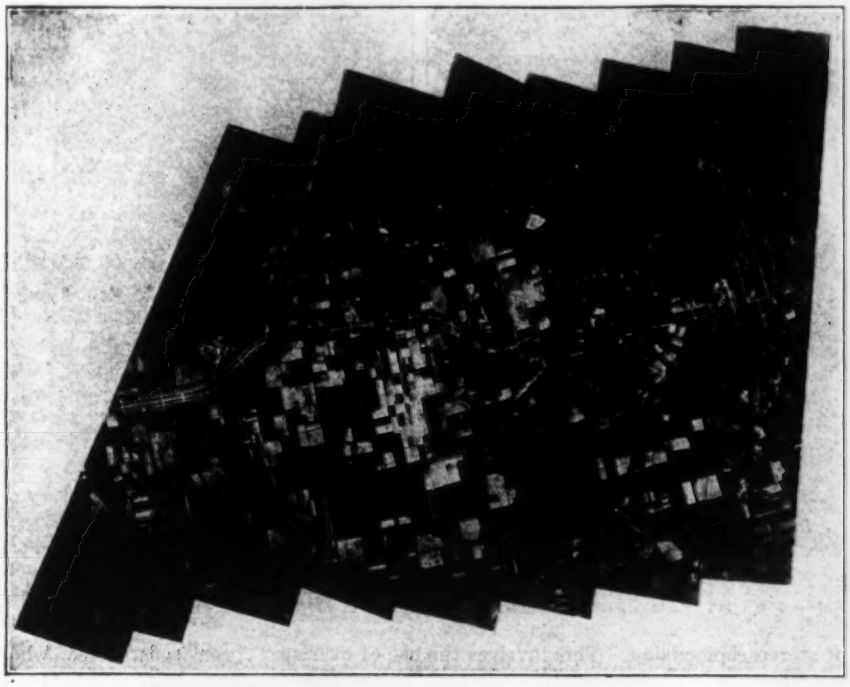

FIG. 7. SERIES OF PHOTOGRAPHS TAKEN WITH THE AIRPLANE CAMERA AFTER BEING REDUCED TO HORIZONTAL PLANE AND JOINED

The transforming camera is an instrument for doing accurate work. It is necessary that the films or plates be put exactly in their proper positions and that the settings of the scales be correct.

In setting up the transforming camera it is assumed that the focal length of all lenses employed, both in the airplane camera and in the transforming camera, are known, and that the inclination of the pictures to the horizon plane is known or can be found. With these data the setting of the instrument can be made after certain simple trigonometric calculations are completed, or the setting may be taken from charts constructed for the purpose. The charts are graphical representations of the trigonometric formulas, and simplify greatly the work of making transformations. The camera is provided with scales and verniers so that the settings may be made with the required accuracy. It is best, nearly always, to have solutions represented graphically.

The inclined airplane photograph shows distant objects on a smaller scale than the near objects, so that the problem of the transformer is to restore a uniform scale to the picture by enlarging or reducing some part of it. Ordinarily, one part of the photograph is enlarged, another is reduced, and the two parts are separated by a line where no change has taken place.

The procedure followed so far in working up the airplane photographs is, first, to transform the side pictures to the plane of the central picture, Fig. 6, and when necessary all three to the horizontal plane, and then by an independent operation to bring all the pictures to the required scale, which as a rule is much smaller than the approximately 1:10,000 scale on which the original pictures were taken. After being brought to the chosen scale the pictures are cut to fit and joined together, Fig. 7. A certain amount of independent horizontal control is needed in this method of mapping as in all others, particularly if an extensive area is to be mapped, but our experience is not yet wide enough to show just how much of such control will be required. It will, of course, depend in part on the scale of the map.

Chief Difficulties—The chief sources of difficulty that arise in making maps from airplane photographs lie first in the lack of suitable means for obtaining the data for transforming the inclined pictures into a truly horizontal position, and, second, in the errors introduced into the pictures by relief of the terrain. The first of these has already been spoken of in describing the airplane camera, and will be solved by installing in the camera the means for recording on the film at the time of exposure the direction and amount of inclination of the central negative. It may be solved in another way if sufficient horizontal control is available, for three or more points on the photograph may be brought into coincidence with corresponding known points plotted on the ground glass of the transforming camera, or, rather, on a tracing paper which can be compared directly with the image on the ground glass, and this of itself brings the picture into the horizontal position.

The second source of difficulty—that arising from relief of the terrain—becomes of greater and greater importance as the relief increases. If the scale of the map is large the error must be taken into consideration even when the relief is small. Apparently, the errors of relief cannot be corrected directly by photographic means, and for the proper location of individual points it becomes necessary to determine the station point or the point on the ground directly below the camera at the moment of exposure, and to find the position of the desired points by intersections from two photographs. This adds an extra operation to the work which it is desirable to avoid where it is possible. Another line of attack on the errors brought in by relief is through the properties

FIG. 8. ON LEFT, ONE OF THE SIDE PICTURES TAKEN WITH AIRPLANE CAMERA; ON RIGHT, SAME PICTURE TRANSFORMED TO THE PLANE OF THE HORIZON

of stereoscopic vision. This involves the use of overlapping pictures and some instrument such as the stereocomparator, constructed for accurately measuring parallax, which may be employed in correcting errors of relief, and if the necessary data are obtained affords an elegant method of drawing the contours to express the relief. This important part of the work is a feature on which we have hardly touched as yet. Fortunately, a certain amount of error due to relief comes within the limits of error for the scale of the maps usually made in this country. "Mosaic" is a term commonly employed to designate most of the maps made from airplane photographs. It will be of interest to make a comparison between such maps and maps made by the method just described.

The design of airplane cameras and the focal lengths of the lenses used vary widely, but the capacity of the lens is practically the same in all. The lens is a "fast" lens of moderate angle whose field of view is further reduced in many instances owing to the size of plate used.

The advantages of the method under consideration may be divided into two classes, those arising from the use of the multiple camera and those due to the use of the transforming camera. It will be well to state again that there would be little advantage in the use of a multiple camera if it were possible to get well corrected fast lenses of wide angle and good illumination. The chief advantage of the multiple camera over the single-lens camera is the increased field of view which makes it possible to cover a given area with fewer flights and therefore in shorter time and at less expense. The area covered by the three pictures of the three-lens camera at a given elevation is about four times the area covered by the central picture alone, and this is roughly the ratio that holds between the three-lens camera and most of the single-lens cameras. Furthermore, the three-lens camera reduces the probability of leaving parts of the terrain unphotographed and make easier the final assembly of the pictures. A uniform overlap in the series of pictures made during successive parallel flights is difficult to maintain, so that frequently it is found either that the overlap is too great or that a part of the terrain is unphotographed. A wide field of view in the airplane camera helps to minimize this difficulty. The advantage due to the use of the transforming camera is chiefly that it makes possible the use of pictures that without it would be unusable or greatly in error because the subject photographed was not parallel to the plate and therefore the pictures do not have a uniform scale, but no advantages arising from it are such that they may not be enjoyed in either method. It would be much more nearly correct to say that until the means is devised for keeping the camera plate in a horizontal position the transforming camera is essential to either method if accurate work is to be done. So far as my knowledge goes, no airplane camera has yet been constructed whose pictures are not subject in some degree to errors arising from the tilt of the plane. In practically all, the error may be, and often is, much greater than any allowable error.

Advantages of Airplane Photographs—The advantages that will arise from the use of photographs taken from the airplane or dirigible airship for the making of maps can hardly be overestimated. These advantages are of many kinds and include among others greatly increased speed, greater accuracy in details, reduction in cost, and, for special purposes such as the use of aircraft pilots, the possibility of representing on the map the actual appearance of the terrain as it is seen from above. Furthermore, it will make possible the mapping of areas which, because they lack roads and other means of transportation, or for other reasons, are now practically inaccessible. When a strip of country from three to five or more miles wide can be photographed at the rate of 75 or 100 miles per hour, depending upon the speed of the airplane, it is not difficult to see that the length of time per square mile devoted to actual field work in the older, established methods now in use must be even hundreds of times greater than in the new.

The errors that arise from the relief of the terrain have been referred to and are fully appreciated, and for that reason it is believed that the first application of the method should be in areas of low relief. Many thousands of square miles of such land are still unmapped in the United States, including most of the Atlantic and Gulf coastal plains as well as great areas in the West. The coastal plain in particular is well adapted to test the merits of the photographic method of mapping, for it is a region of low relief, largely unmapped, and in many parts extremely difficult of access.

Another field of application in which it is believed that the photographic method will be most useful is in the revision of existing maps, as in the addition of features like new roads built since the map was made, or of timbered areas not mapped originally. Only those who have had experience in the study of airplane photographs can realize fully the wealth of material they contain for the mapmaker.

Chicago Chapter, A. A. E., Adopts Schedule of Salaries

From Chief Engineers to Draftsmen, Rodmen and Inspectors on State, County, Municipal, Corporate and Private Work

A COMPREHENSIVE list of salaries for a wide range of engineering positions in varied lines of work has been adopted by the Chicago Chapter of the American Association of Engineers. This has been referred to the association with the suggestion that it be utilized in a nation-wide study of the subject, for the formulation of a general schedule of salaries. The present schedule covers architectural, highway, municipal, state and electric-railway work (steam-railway work has been covered by the parent association); county and rural positions, large engineering organizations, public-utility boards and corporations, telephone work and expert service.

It is explained that the salaries recommended are for positions which provide continuous employment and offer advancement in rank and pay as a reward for efficient service. For seasonal employment, where the work continues from year to year, but is interrupted by idle seasons, it is suggested that the pay should be such as to amount to about half pay during the period of enforced idleness. Thus, for an eight-month season, where the schedule rate is $2400 per year, the pay should be $250 per month. For temporary positions, where there is no developing future, the pay should be 50% above the schedule, in order to provide greater incentive for good work and repay the employee for changing location.

A few revisions were made at a meeting at which the schedule was discussed, and these are included in the lists given below. The work was done by a committee composed of A. M. Van Auken, chairman; W. H. Dean, G. S. Eaton, W. A. Ireland, Langdon Pearse and J. H. Prior.

Proposed Schedule of Salaries Adopted by the Chicago Chapter

Architectural Engineers—The committee states that to those who are not architects the rates seem to be low, but the schedule is thought to be reasonably fair to employer and employee. There appear to be no uniform rules as to education or training required for the positions.

Architect in charge of office	$5000–$8000
Designing draftsman	4000– 5000
Construction design draftsman	4000– 5000
Outside superintendent	4000– 5000
Senior draftsman	2400– 3000
Junior draftsman	1500– 2100
Student draftsman	900– 1200

Road Engineers—This schedule is for a state having 60,000 to 100,000 miles of roads and in which the highway department spends not less than $5,000,000 annually

Chief highway engineer	$8,000–$10,000
Road engineer	5,000– 7,000
Maintenance engineer	4,500– 6,000
Bridge engineer	4,500– 6,000
Engineer of tests	3,000– 4,000
Division engineer (7,000 to 10,000 miles)	3,600– 5,000
Assistant engineer	2,700– 3,600
Resident engineer	2,700– 3,600
Chief designing engineer	3,000– 4,000
Designing engineer	2,700– 3,300
Junior engineer, class A	2,100– 2,700
Junior engineer, class B	1,500– 1,800
Inspector*	1,320– 1,800

*Technical training desirable but not essential, but must have had experience in highway construction if lacking such training.

Municipal Engineers—The proposed schedules for municipal engineers are as follows:

City engineer: annual work, $5,000,000	$12,000–$15,000
City engineer: annual work, $2,500,000	8,000– 10,000
City engineer: annual work, $1,000,000	6,000– 7,500
City engineer: annual work, $500,000	4,000– 5,000
Department engineer	5,000– 7,500
Division engineer	4,000– 7,500
Assistant engineer	3,000– 3,600
Instrumentman (preferably technical graduate)	2,000– 2,400
Rodman (high-school, 2nd grade)	1,080– 1,500
Inspector	1,380– 1,800
Architect	3,000– 5,000
Designing engineer (technical graduate, 10 years' experience)	4,000– 6,000
Designer (technical graduate, 5 years' experience)	3,300– 4,400
Detailer (technical graduate preferably)	2,000– 3,000
Tracer (technical high school)	1,200– 1,800
Draftsman, architectural	1,800– 3,000
Draftsman, map or topographic	1,800– 2,400
Draftsman, structural	1,800– 2,400

Electric Railway Engineers—For the case of railways with 60 miles of track:

Chief engineer (track, structures and transmission lines)	$3,600– $4,800
Assistant engineer (field)	2,400– 3,000
Roadmaster (preferably technical education)	2,400– 3,000
Mechanical-electrical engineer	4,200– 5,400
Office engineer (mechanical-electrical)	2,400– 3,000

For railways with 200 miles of track:

Chief engineer	$4,000– $5,400
Assistant engineer	2,400– 3,000
Roadmaster	2,400– 3,600
Electrical-mechanical engineer	4,500– 6,000
Assistant engineer (electrical-mechanical)	2,400– 3,000

County Surveyor—As a rule this is not a salaried position, but it is of such importance that a sound policy would provide an office and pay for keeping open a stated number of days per week, depending upon the wealth and population of the county. The pay per day for land surveying should be adjusted to correspond with the value of the land, as follows, since the surveyor is responsible and may be sued for damages due to erroneous work:

	Surveyor	Assistant
Land up to $25 per acre	$12.50	$3.75
Land at $25 to $200 per acre	18.00	5.00
Land over $200 per acre	20.00	5.00

A similar rate should be paid for work of the intermittent class or for drainage, levee or road work, with pay for a specific number of days per month to cover consultation and correspondence.

Deputy county surveyor	$3000–$4200
Employees on drafting and instrument work	2100– 2700

County Engineer—Good roads organization in counties spending at least $500,000 annually on highway work:

County highway engineer	$4200
Assistant engineer	3000
Junior engineer, class A	2400
Junior engineer, class B	1800
Inspector (for qualifications see under "Road Engineers")	1500

A similar organization is desirable for levee and drainage work, but must adapt itself to wider variation than the road work. Such adaptations can be made according to the particular work in hand.

State Public Utility Board—For the engineering department of a board in a state having a population of 5,000,000:

Chief engineer	$12,000–$15,000
Assistant chief engineer	9,000– 10,000
Chief of railroad division	8,000– 9,000
Chief of gas division	6,000– 7,500
Chief of telephone division	6,000– 7,500
Chief of waterworks division	6,000– 7,500
Chief of service division	6,000– 7,500
Assistant engineer, grade 1	3,600– 4,800
Assistant engineer, grade 2	3,000– 3,300
Assistant engineer, grade 3	2,400– 2,700
Assistant engineer, grade 4	1,800– 2,100

State Public Improvement Project—For such a project as the Illinois River improvement:

Chief engineer	$15,000
Assistant chief engineer	9,000
Principal assistant engineer	8,000
Bridge engineer	7,500
Office engineer	6,000
Field engineer	6,000
Office and field assistants	Same as in municipal schedule

Large Structural Engineering Organization—Proposed schedules in this field are as follows:

Chief engineer	$12,000
Assistant chief engineer	9,000
Construction engineer	$3,600– 6,000
Inspecting engineer (10 years' experience)	3,000– 4,200
Inspecting engineer, junior grade	1,800– 2,700
Office engineer	4,800– 6,000
Engineer of design	4,200– 5,000
Assistant engineer of design	2,400– 3,000
Engineer of estimates	3,300– 4,000
Squad engineer	3,300– 4,000
Assistant engineer, class 1	3,000– 3,600
Assistant engineer, class 2	2,400– 2,700
Junior engineer (technical education, with or without experience)	1,500– 2,100
Student engineer	1,000– 1,400

Expert Service—An engineer having a standing equal to the chief engineer of a railway or city engineer of a city spending $2,000,000 annually, $100 per day. An engineer who can qualify in court to give expert testimony, $25 per day. Intermediate figures for engineers of intermediate rank. All incidental expenses should be in addition to the rate named and should be paid for. Court testimony simply identifying a map or plan is not considered expert testimony.

Mortar Test Does Not Insure Good Concrete Aggregate

Experiments Show That Commonly Assumed Relation To Standard Ottawa Sand Test Has No Effect on Compressive Strength

BY CLEMENT C. WILLIAMS
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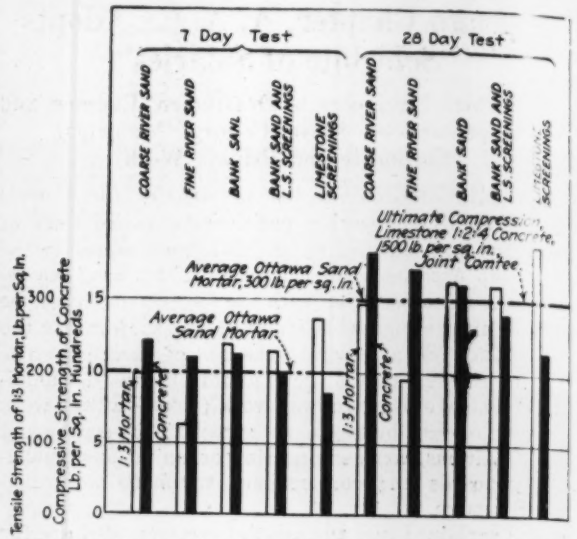
Lawrence, Kan.

CONCRETE specifications frequently contain the clause "the tensile strength of a mortar made of one part cement to three parts of the aggregate shall be at least 75% of ['equal to,' in the Joint Committee report] the strength of a mortar of one part cement to three parts Ottawa standard sand." Some tests recently made by the writer show that this precaution does not insure an aggregate giving a concrete strong in compression.

The tests included five different materials: A coarse river sand, a fine river sand, a coarse bank sand containing some clay, a mixture of the bank sand and limestone screenings, and limestone screenings crusher run. The screenings contained from 5 to 15% of dust passing an 80-mesh screen. The results of the tests are tabulated herewith and also shown graphically. Each result represents an average of approximately 20 individual tests. The coarse aggregate was somewhat variable, but was chiefly crushed limestone fairly well graded. The concrete was nominally a 1:2:4 mixture.

From these data it is obvious that the fine aggregate which gives a mortar of high tensile strength does not necessarily yield a concrete having a high compressive strength. Moreover, since Ottawa standard sand 1:3 mortar has an average tensile strength at seven days of about 200 lb. per square inch and at 28 days of 300 lb. per square inch, it is also apparent that a fine aggregate which yields a mortar having 75% of this strength or even equal to it may not produce a strong concrete.



COMPARISON OF MORTAR AND CONCRETE TESTS WITH OTTAWA SAND MORTAR TESTS

Not only in these special tests with limestone screenings did this fact become manifest, but similar results were observed with screenings from a local sandstone quarry. In this case the screenings gave a 1:3 mortar that exceeded the standard sand mortar in strength, but they proved to be entirely unfit for making concrete.

A 1:3 mortar is a comparatively lean mortar, especially with Ottawa standard sand, which is nearly uniform in size and contains a large amount of voids (about 40%). It is a matter of common observation in the laboratory that a well graded sand, even if inferior in other respects, will produce a stronger 1:3 mortar than Ottawa standard sand. In the case of a fine aggregate containing a considerable amount of silt, such as crusher-run screenings, the fine particles help fill the voids and bring about a better distribution of the available cement in the lean mortar and hence produce a denser and stronger mortar.

COMPARISON OF MORTAR AND CONCRETE TESTS

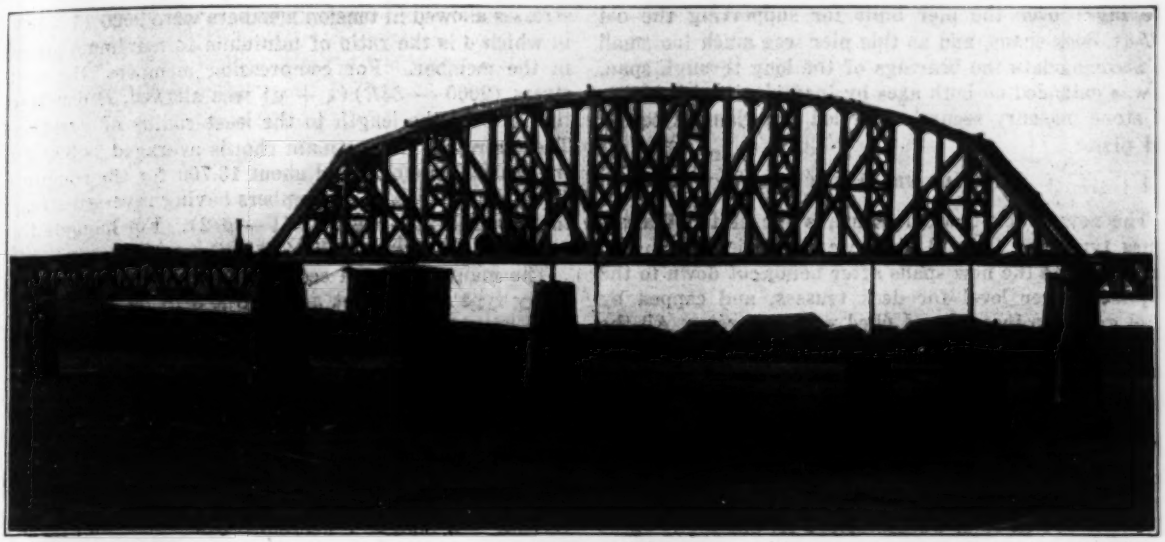
Aggregate	Average Tensile Strength of Mortar Lb. per Sq.In. 7 Days	28 Days	Average Compressive Strength of Concrete Lb. per Sq.In. 7 Days	28 Days
Coarse river sand	201	294	1210	1810
Fine river sand	123	180	1120	1690
Bank sand	239	323	1130	1590
Bank sand and screenings	229	318	1010	1380
Limestone screenings	273	364	847	1160

Incidentally, attention may be called to the fact that while stone screenings prepared in the laboratory free from an excess of dust may produce a strong mortar and give good results as a fine aggregate for concrete, commercial screenings on the market, being crusher run and containing a large proportion of clay and stone dust from the quarry, generally do not yield a strong concrete.

If the mortar test is to be used at all as a criterion for judging fine aggregates, lean mortars should be used to try materials for lean concrete and richer mortars for richer concrete mixtures. The only reliable criterion is a test of the concrete itself made up with the coarse aggregate to be used on the work. However, the old specification that the fine aggregate shall be clean and coarse and shall consist of hard, durable grains well graded in size from finest to coarsest particles, if strictly observed, will give satisfactory results.

Design of New Superstructure of Louisville Bridge With 644-Foot Riveted Span

Historic Bridge One Mile Long Replaced by Double-Track Spans on Same Masonry Piers—Details of Design and of Deck Trusses and Lift Span



RIVETED SPAN 644 FEET LONG REPLACES THE 400-FOOT CHANNEL SPAN OF OLD BRIDGE—OLD INTERMEDIATE PIER BEING REMOVED

REPLACEMENT of the Pennsylvania's historic Fink-truss bridge over the Ohio River at Louisville, Ky., involved the design and erection under exceptional conditions of the longest and heaviest simple-truss riveted span in existence, 643 ft. 10½ in. in length between the 24-in. end pins. The adoption of riveted instead of pin-connected trusses resulted mainly from the fact that when the Government ordered the Louisville Bridge Co., a subsidiary of the Pennsylvania Railroad Co., to provide a 600-ft. clear channel instead of the 400-ft. Indiana channel of the old bridge, the other through span had been designed and fabricated with riveted trusses. To preserve unity in the structure, therefore, the same type was adopted. The 644-ft. truss contains top and bottom chords of special section, 1½-in. gusset plates spliced into the main webs of the chords, and in the web members transverse diaphragms and longitudinal end stiffening diaphragms.

This article describes the principal features of the design of the long span, typical details of the deck trusses and special details of the 260-ft. lift span over the Louisville Canal. The erection of the new trusses around the old structure while traffic was maintained, the remodeling of the masonry piers to carry the new superstructure, and the erection equipment will discussed in a separate article.

The original superstructure of this bridge, built in 1870, was composed of 26 deck truss spans and two through-truss channel spans, the total length center to center of the end masonry supports being 5294 ft. The deck spans were of the Fink-truss type, except the swing span over the Portland Canal at the Kentucky end, which was of the Warren type. This deck swing span was replaced about 17 years ago by a through-truss span. The two original through spans, one 370 ft. and one 400 ft. long, were of the Warren type. The original bridge was described in *Engineering News* of Feb. 8, 1917, p. 217.

When it was decided to replace the old bridge with a new one, it was found that the existing masonry would, with the use of pier girders, be long enough to take the superstructure for a double-track bridge, and it was concluded to make the renewal with a double-track superstructure on the old masonry. To this end, request was made of the War Department for a permit to use such falsework as would be necessary to carry out the erection; at the same time the offer was made to replace the existing swing span by a vertical lift span giving 200 ft. clear opening.

The response from the department was an order not only to provide a lift span for the canal opening, but also to increase the span over the Indiana channel from 400 ft. to a length that would provide a 600-ft. clear opening for the channel.

Required 644-Foot Span.—This order brought about a long battle in the courts regarding the increase in length of the 400-ft. channel span, and a decision was not handed down by the Supreme Court until January, 1917. In the meantime the replacement of the bridge, which was begun in June, 1916, had been proceeding rapidly, and the 370-ft. through-channel span, which was the only other fixed through-truss span in the bridge, was completely designed and fabricated. As the 370-ft. span was designed as a riveted-truss span, in order to preserve unity of design it was decided to build a 644-ft. span of the same type, and the subpanel outline of the long span, as indicated in the diagram herewith, was adopted.

A K-truss outline was also investigated, but for the above reason was not used, although the greater simplic-

ity in detailing of joint connections was recognized as a real advantage.

As the order of the War Department called for a 600-ft. clear opening under the long span, it was necessary, to meet this requirement, to remove the pier between the old 400-ft. span and one of the 245-ft. deck spans just south of it. This brought the south end of the long span (643 ft. 10½ in. between centers of end bearings) over the pier built for supporting the old 245-ft. deck spans, and as this pier was much too small to accommodate the bearings of the long through span, it was extended on both axes by incasing it with a ring of stone masonry securely doweled and clamped to the old pier.

Old Masonry Piers Used

The new double-track deck spans are of the Warren truss type, and the old piers were sufficiently long to accommodate the new spans after being cut down to the required lower level for deck trusses, and capped by steel grillages incased and filled with concrete. All the new spans are therefore of practically the same length as the old spans, except the Indiana channel span and the lift span over the canal.

A striking illustration of the difference in weight of the new and the old structures is seen in the fact that the new 370-ft. span weighs 12,272 lb. per foot as compared with 3050 lb. per foot for the old structure. The new 644-ft. span weighs 19,650 lb. per foot. These great weights resulted largely from high assumed live loads and the unit stresses adopted.

Live Loads and Impact—The live loading specified for this span consisted of a uniform load of 5000 lb. per foot of track and a concentrated single load of 60,000 lb., except for the floor system and web members of trusses, which are designed to support a uniform load of 5500 lb. and a concentration of 66,000 pounds.

In addition to this live load, a shock stress was introduced in the computation of all web members. This stress for verticals was equal to 50% of the concentrated live load, which was increased for diagonals by multiplying by the secant of the angle of inclination.

The wind load was assumed at 900 lb. per foot, moving on the top chord, and 1200 lb. per foot moving on the bottom chord.

Special Steel Adopted—A special high-carbon steel was required for all the main members of this truss. The ultimate strength was specified as 66,000 to 76,000 lb. per square inch, and the yield point, determined by drop of beam, at 38,000 lb. per square inch minimum. For this steel the elongation in 8 in. was required to be 1,400,000 divided by the tensile strength as a minimum, with a reduction of area of 35% minimum allowable, except that for thicknesses 1 in. or over the percentage of elongation might be reduced by 1 for each increase in thickness of ¼ in. or fraction, but not to be less than 16%. Similarly, for steel thicker than 1 in. the percentage of reduction might be reduced by 1 for each ¼ in. or fraction over 1 in., but not below 30%. Rigid requirements for cold bending tests were specified.

In case the ultimate strength fell outside the specified limits by less than 1000 lb., or in case the elastic limit fell below the specified minimum by less than the same amount, all other requirements being fulfilled, then two more tests might be taken, and if both retests filled all the requirements, the material would be accepted. It was required that when a melt of steel was rolled into several shapes, each shape must be separately tested. It was further specified that in case a melt was rolled into plates 1 in. thick or over and the tensile tests showed any wide variation in physical results, a test should be made on each plate and each plate accepted or rejected according as it met the requirements of the specifications.

Unit Stresses and Make-up of Sections—The unit stresses allowed in tension members were 9000 $(1 + \phi)$, in which ϕ is the ratio of minimum to maximum stress in the member. For compression members, the unit stress $(9000 - 33R)(1 + \phi)$ was allowed, R denoting the ratio of the length to the least radius of gyration. These stresses for the main chords averaged 14,890 for the tension members and about 13,760 for the compression upper chords. For members having reversed stress, the allowable unit was $9000(1 - \phi/2)$. For hangers the unit stress was made $8000(1 + \phi)$.

The main top chord sections are of an exceptionally heavy type using eight angles 8 x 8 in. and 8 x 6 in., with 60-in. webs and 60-in. cover plate. Increase in section for center chords is obtained by adding plates to the outside of the vertical webs.

Special Section for Lower Chord

The lower chord is of special section, as shown by the drawings, in which the constant area consists of eight angles, four horizontal plates, laced, and six 60-in. vertical web plates. The additional areas required for higher stress in the center chords are obtained by adding plates both inside and outside of the vertical webs.

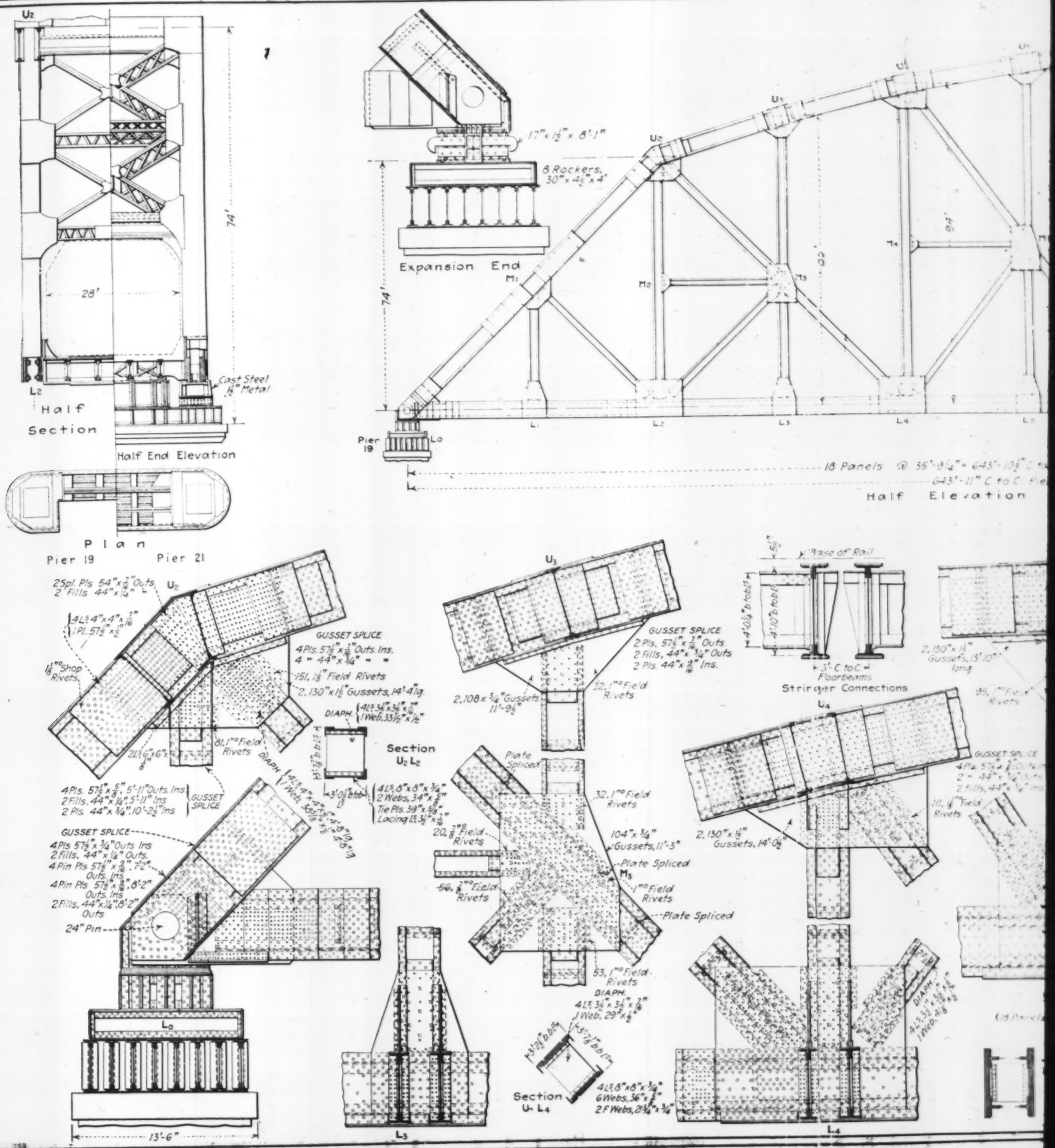
The thickness of main material in top and bottom chords does not exceed ¾ in., the web plates being spliced to the big ¾- or 1½-in. connection plates, which were inserted in the chords with $\frac{1}{32}$- or $\frac{1}{16}$-in. clearance.

In the detailing of all the main members, the plates and lacing bars or angles are placed inside the corner angles. This gives a much more finished effect, with square outlines to improve the general appearance.

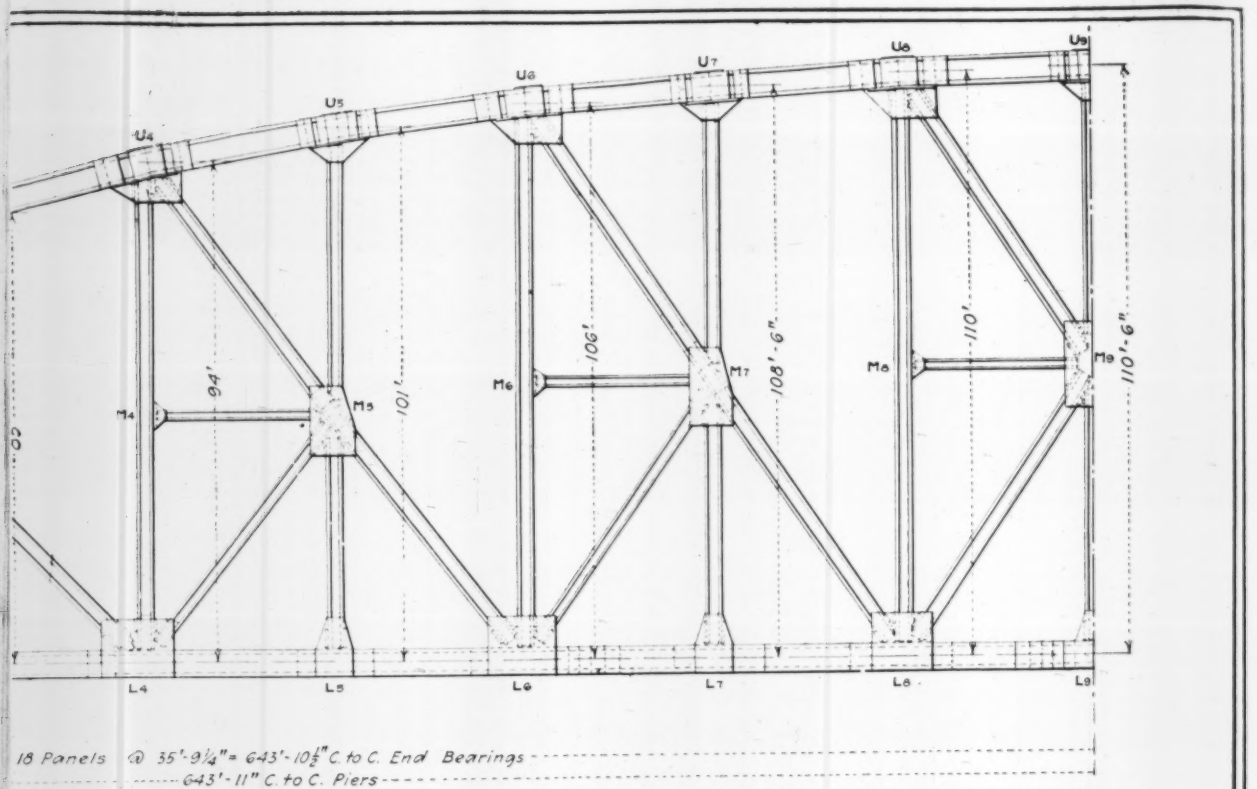
Floor and Lateral Systems—The old floor system had to be removed and replaced, under traffic, by the new one, and in the designing of the new floor it was decided to use double floor-beams at each panel point so that each panel of the floor would be independent, and could be erected as a unit. This simplified the erection of the floor system considerably. The use of these double floor-beams also prevents the racking of the floor system, due to deflection of trusses under loads, which takes place in long spans where a continuous floor system is used.

Another special feature is seen in the arrangement of the top lateral system, the diagonals being connected to the top chords at mid-panel, with points of intersection opposite the panel points to which connection is made of struts. Curved gussets were used throughout the sway bracing, the radius being 4 ft. Intermediate sway bracing was introduced only at the main vertical posts, two panels apart.

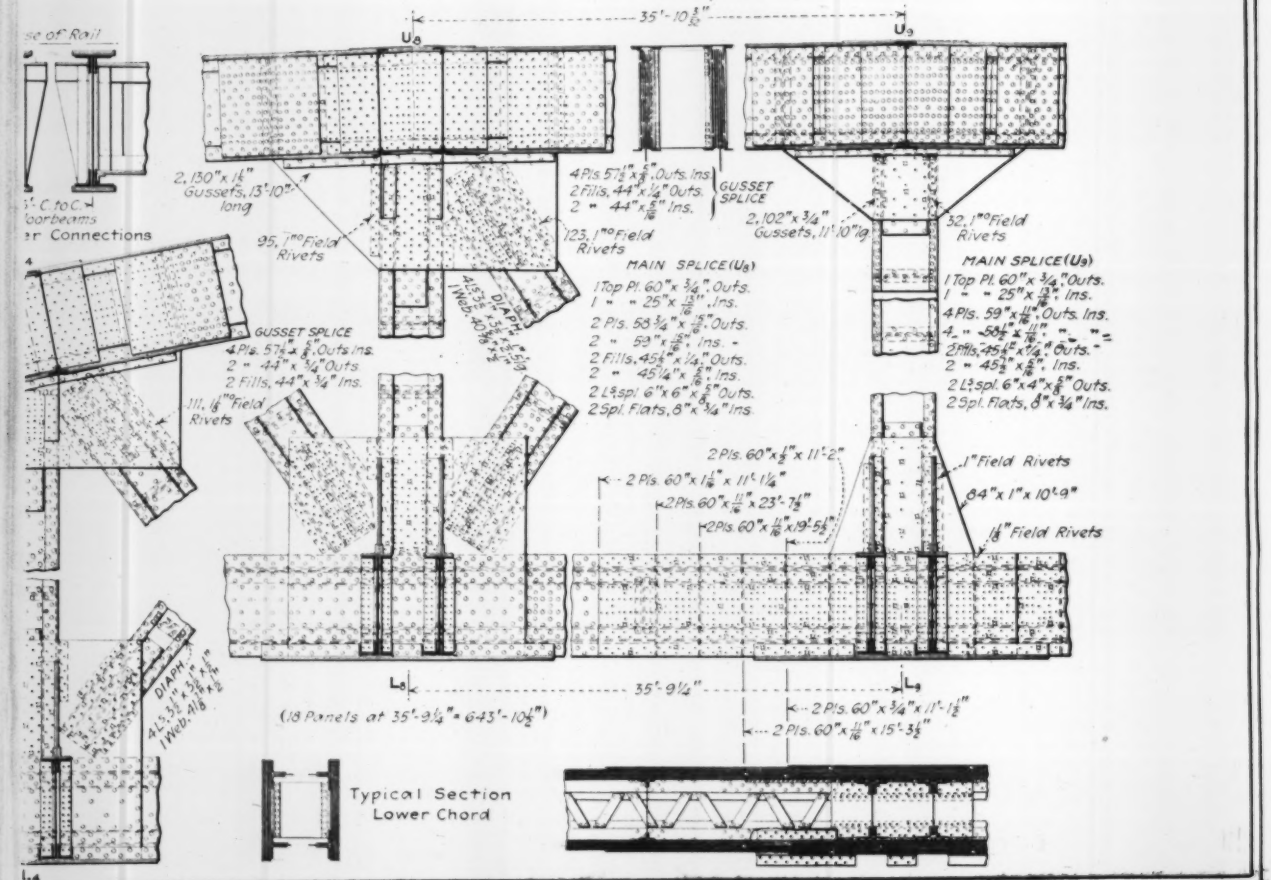
Design of Chords, Web Members and Chord Splices—In the design of the cords, maximum stress was computed for an assumption of full loading on both tracks simultaneously. In designing the web system, the maximum and minimum stresses were found by the following assumptions: (1) For maximum stresses—trains on each track headed same way, directly opposite each other and passing simultaneously across the bridge; (2) for minimum stresses—trains on each track, headed same way but opposite to the direction causing maximum



GENERAL ELEVATION, TYPICAL JOINT DETAILS AND CHORD SPLICES OF 644-FOOT RIVETED TRUSS OF THE PENNSYLVANIA RAILR



Half Elevation


35'-10½"
U8
U9
2, 130" x 1½" Gussets, 13'-10" long
95, 1" ø Field Rivets
123, 1" ø Field Rivets
4 Pls. 57½" x ⅝", Outs. Ins
2 Fills, 44" x ¼" Outs.
2 " 44" x ⅜" Ins.
GUSSET SPLICE
2, 102" x ¾" Gussets, 11'-10" long
32, 1" ø Field Rivets
MAIN SPLICE (U8)
1 Top Pl. 60" x ¾", Outs.
1 " " 25" x 15/16", Ins.
2 Pls. 58¾" x ⅝", Outs.
2 " 59" x 15/16", Ins.
2 Fills, 45¼" x ¼", Outs.
2 " 45¼" x ⅜", Ins.
2 L's spl. 6" x 6" x ⅝", Outs.
2 Spl. Flats, 8" x ¾", Ins.
MAIN SPLICE (U9)
1 Top Pl. 60" x ¾", Outs.
1 " " 25" x 15/16", Ins.
4 Pls. 59" x 11/16", Outs. Ins.
4 " 58¾" x 11/16", " "
2 Fills, 45¼" x ¼", Outs.
2 " 45¼" x ⅜", Ins.
2 L's spl. 6" x 4" x ⅝", Outs.
2 Spl. Flats, 8" x ¾", Ins.
GUSSET SPLICE
4 Pls. 57½" x ⅝", Outs. Ins.
2 " 44" x ¼", Outs.
2 Fills, 44" x ¼", Ins.
111, 1⅛" ø Field Rivets
2 Pls. 60" x ½" x 11'-2"
2 Pls. 60" x 1⅛" x 11'-1¼"
2 Pls. 60" x 11/16" x 23'-7½"
2 Pls. 60" x 11/16" x 19'-5½"
1" ø Field Rivets
84" x 1" x 10'-9"
⅛" ø Field Rivets
L8
35'-9¼"
L9
(18 Panels at 35'-9¼" = 643'-10½")
2 Pls. 60" x ¾" x 11'-1½"
2 Pls. 60" x 11/16" x 15'-3½"
Typical Section Lower Chord
L4

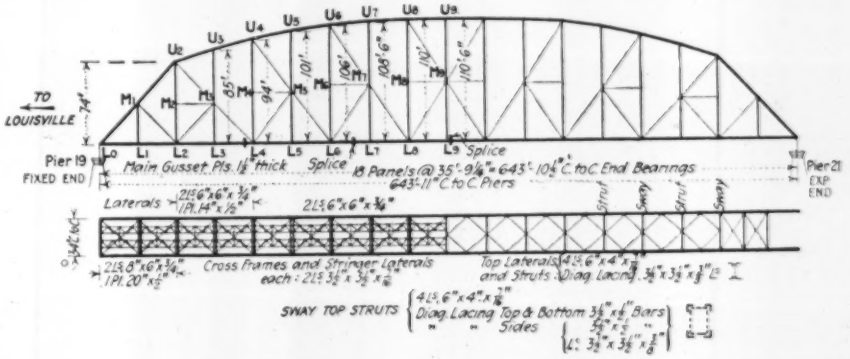
OF THE PENNSYLVANIA RAILROAD'S BRIDGE OVER THE OHIO RIVER AT LOUISVILLE, KY.

the trains directly opposite and passing simultaneously across the bridge.

While the above method was used in obtaining the maximum and minimum stresses for the web members subject to reversal of live-load stresses, the value of ϕ used in connection with the above stresses was based on *immediately successive* values of a maximum and a minimum. It is obvious that the minimum stress described above cannot immediately succeed a maximum stress, or vice versa, until both trains causing the maximum have passed off the bridge and two more trains come on the bridge advancing in the opposite direction, which cannot be considered as producing immediately successive stresses.

It was, therefore, assumed that in order that a maximum and a minimum stress could be immediately successive, the maximum stress was produced by one train on the near track, and the minimum stress by one train on the far track, but facing in the opposite direction. Since the tracks are 13 ft. apart center to center and the trusses are 34 ft. center to center, 69% of the maximum live-load stress was considered

GENERAL DIMENSIONS OF 644-FOOT SPAN — SECTIONS FOR LATERAL BRACING



STRESSES AND SECTIONS FOR 644-FOOT TRUSS OF OHIO RIVE BRIDGE AT LOUISVILLE, KY.

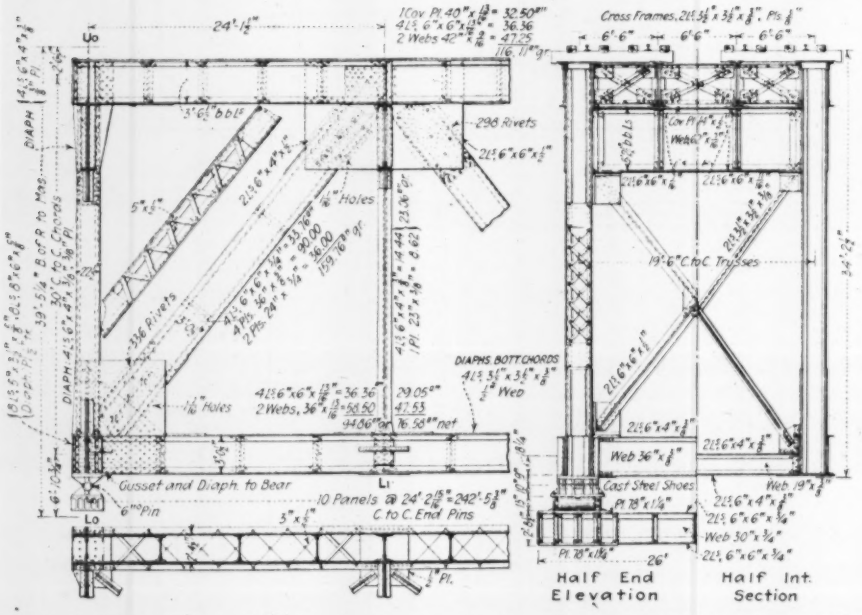
Member	Dead Load Stress*	Live Load Stresses Unif.	Cone.	Shock	Total Stress	l/r	Unit Stress, Lb. per Sq.In.
Lo-L4	2919.9	1486.8	62.0	....	4468.7	....	14,890
L4-L6	3923.8	1998.0	83.2	....	6005.0	....	14,890
L6-L8	4440.0	2260.8	94.2	....	6795.0	....	14,890
L8-L9	4744.0	2415.6	100.7	....	7260.3	....	14,890
U2-U3	—3966.3	—2019.6	—84.2	....	—6070.1	20.7	13,760
U3-U4	—3909.7	—1990.8	—83.0	....	—5983.5	20.4	13,770
U4-U5	—4404.6	—2242.8	—93.5	....	—6740.9	20.9	13,740
U5-U6	—4362.2	—2221.2	—92.6	....	—6676.0	20.7	13,760
U6-U7	—4637.9	—2361.6	—98.4	....	—7097.9	21.1	13,730
U7-U8	—4630.9	—2358.0	—98.3	....	—7086.9	21.1	13,730
U8-U9	—4630.9	—2358.0	—98.3	....	—7086.9	21.1	13,730
Lo-M1	—4192.5	—2300.0	—81.8	46.2	—6620.5	29.5	13,120
M1-U2	—3945.1	—2232.0	—81.8	46.2	—6305.1	29.5	13,050
U2-M3	1491.8	1000.0 —156.0	40.9 —25.7	46.2 —46.2	1263.9† 2578.9		14,710
M3-L4	1244.3	932.0 —224.0	40.9 —25.7	46.2 —46.2	948.4† 2263.4		14,330
U4-M5	869.6	776.0 —284.0	36.3 —31.0	42.9 —42.9	511.7† 1724.8		13,680
M5-L6	643.4	712.0 —348.4	36.3 —31.0	42.9 —42.9	221.5† 1434.6		12,890
U6-M7	544.4	688.0 —384.0	37.6 —31.7	39.6 —39.6	89.1† 1309.6		12,380
M7-L8	332.3	628.0 —444.0	37.6 —31.7	39.6 —39.6	—183.0 1037.5		10,900
U8-M9	84.8	532.0 —532.0	37.0 —37.0	39.6 —39.6	693.4† —523.8	71.7	3,930
M9-L8	—212.1	472.0 —592.0	37.0 —37.0	39.6 —39.6	336.5† —880.7	71.7	7,040
M1-L2	—247.5	—140.0	—46.2	—46.2	—479.9	64.6	10,405
L2-M3	—247.5	—140.0	—46.2	—46.2	—479.9	64.6	10,405
L4-M5	—226.2	—128.0	—41.6	—42.9	—438.7	74.0	9,940
L6-M7	212.1	—120.0	—39.6	—39.6	—411.3	80.1	9,630
U2-L2	424.2	400.0	66.0	33.0	923.2		13,140
U4-L4	—643.4	—536.0 332.0	—25.1 36.3	—33.0 33.0	—242.1† —1237.5	49.0	11,010
U6-L6	—268.7	—440.0 448.0	—24.4 37.0	—33.0 33.0	249.3† —766.1	55.3	8,440
U8-L8	28.3	—380.0 524.0	—23.1 35.0	—33.0 33.0	—407.8† 620.3		7,900
U3-M3	70.7	112.5	....	....	183.2		12,470
U5-M5	99.0	127.5	....	....	226.5		12,920
U7-M7	—14.1	67.5	....	....	53.4		7,810
U9-M9	14.1	67.5	....	....	53.4		7,810
Hangers	212.1	200.0	66.0	33.0	511.1		11,320
Reaction	—3181.5	—1800.0	—66.0	—33.0	—5080.5		15,440

Member	Section	Holes Out	Area, Sq.In. Gross	Net
Lo-L4	8 Ls. 8x8x1 in. 4 Pls. 12x1 in. 6 Webs 60x1⅛ in.	16 8 54	369.02	308.12
L4-L6 Add	2 Ins. Pls. 25½x1 in. 2 Webs 60x1 in.	10 18	497.27	412.74
L6-L9	Add 2 Webs 60x1 in.	18	587.27	487.55
L6-L8	Omit 2 ins. pls. 25½x1 in.		549.02	458.36
U2-U4	1 Top Cov. 60x1 in. 4 Outs. Ls 8x6x1 in. 4 Ins. Ls 8x8x1 in. 4 Webs 60x1⅛ in. 4 Webs 60x⅞ in.		453.06	
U4-U6	Add 2 outs. Pls. 43½x1 in.		496.81	
U6-U8 U8-U8'	Add 2 Ins. Pla. 43½x⅞ in.		535.09	
M1-U2	1 Top Cov. 60x1 in. 4 Outs. Ls 8x6x1 in. 4 Ins. Ls 8x8x1 in. 4 Webs 60x1⅛ in. 4 Webs 60x ⅞ in. 2 Outs. Pls. 43½x1 in.		496.81	
Lo-M1	Add 2 Ins. Pls. 43½x1 in.		562.43	
U2-L4	4 Ls. 8x8x1 in 6 Pls. 36x1 in. 2 Pls. 21½x1 in.	8 36 8	213.40	178.90
U4-L6	4 Ls. 8x8x1 in. 4 Pls. 34x⅞ in. 2 Pls. 19½x1 in.	8 20 6	151.89	130.17
U6-L8 U8-M9 L8-M9	4 Ls. 8x8x1 in. 4 Pls. 34x⅞ in. 2 Pls. 19½x1 in.	8 20 6	134.89	115.60
Sub-Diags.	4 Ls. 6x6x⅝ in. 2 Pls. 24x1 in.		47.0	
U2-L2	4 Ls. 8x8x1 in. 2 Pls. 34x1 in.	8 10	88.26	76.01
U4-L4	4 Ls. 8x8x1 in. 4 Pls. 34x⅞ in.		122.26	
U6-L6 U8-L8	4 Ls. 8x8x1 in. 4 Pls. 34x⅞ in.	8 20	105.26	90.51
Sub. Posts	4 Ls. 6x4x⅞ in. 2 Pls. 34½x⅞ in.	8 20	46.94	39.06
Hangers	4 Ls. 6x6x1 in. 2 Pls. 34½x1 in.	8 10	57.50	48.50
Hor.Struts	4 Ls. 6x4x⅞ in. 2 Pls. 20x⅞ in.			
	8 Rollers 30x8½ in. x 4 ft. Built Grillage			

* Dead load stress computed for 9,823 lb. per foot of truss. All total stresses given in thousand pound units.
† Minimum stress to determine Φ.

in connection with 31 per cent. of the minimum live-load stress.

The location of the splices in the lower chord was fixed by erection requirements, which explains why a field splice occurs at L_9, the point of maximum stress. This splice is exceptionally heavy, and, although symmetrical about the center line, considerable care was required in computation to insure sufficient net section, and at the same time provide enough rivets to develop the value of the plate. The top-chord shop splice at U_9 is also especially heavy, because all compression members


Half End Elevation
Half Int. Section
Gusset and Diaph. to Bear
10 Panels @ 24' 2 1/8" = 242' 5 3/8"
C. to C. End Pins
Cast Steel Shoes
Web 36" x 1/2"
Web 19" x 1/2"
19'-6" C. to C. Trusses
296 Rivets
336 Rivets
Diaphs. Bott. Chords
Cross Frames, 2 L's 3 1/2" x 3 1/2" x 1/2", Pls 1/2"

TYPICAL DETAILS OF 242-FOOT DECK TRUSSES CARRYING FLOOR ON TOP CHORDS

were required to be fully spliced, even though the main sections were milled to bear.

The maximum grip of the 1⅛-in. rivets in these heavy splices was 8 1/16 in. It will be noted that countersunk shop rivets are used to hold the plates together for the purpose of preventing separation under the process of reaming. These stitch rivets proved to be very effective in facilitating the work of assembling in the shop and reaming in place, as was required for all main trusses, and also in field riveting.

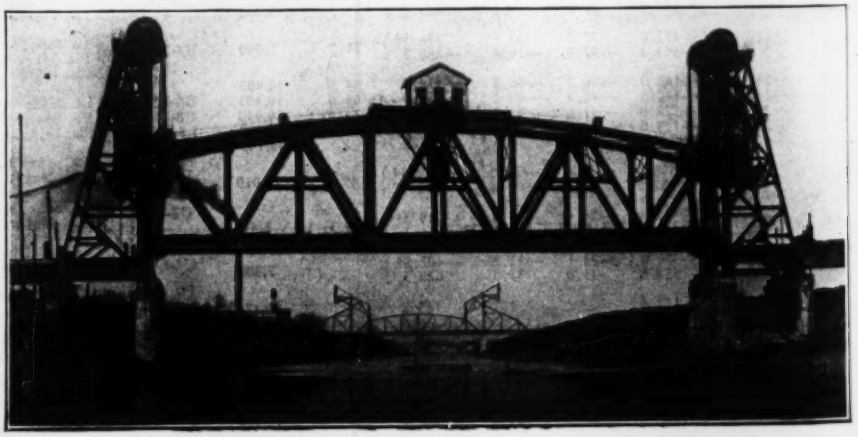
The length of the main plates in these heavy 5-ft. chords was of course limited by the available mill sizes for sheared plates, about 35 ft. This required shop splicing, as is indicated by some of the drawings. Typical joint details are also shown, the heavy hitch angles and the free use of diaphragms being noteworthy. The size of the gusset connection plates was limited by the maximum possible mill sizes, the largest gusset being 130 x 1½ in. at the hip joint U_9.

The hitch angles were made as long as the gusset plates would permit. Longitudinal diaphragms were designed to keep the ends of the main members to exact dimension and facilitate erection, to distribute the stress, and for added stiffness. The intermediate diaphragms in all main members were especially valuable in keeping such large sections out of wind. Drain holes in the plates of these diaphragms were provided to permit the water to run off and prevent rusting.

As seen in the detail drawing, the end shoe is of unusually heavy design and is bored for 24-in. pin; at the expansion end the span is supported upon segmental rockers of 2½ ft. diameter. The main bearing plate is supported by exceptionally heavy grillage girders, as illustrated in the drawing. These substantial pier caps simplified the placement of the end shoes, as any relatively small inaccuracy would not be of such importance as if they were set directly on the masonry.

Typical Details of Deck Spans—The Warren or triangular type was selected for the deck trusses because of its advantages in economy and simplicity of details. The cross-section and the typical details of the 242-ft. deck spans are reproduced, particularly to show the floor construction with track ties supported directly on the top chords of the trusses, the sway bracing, and the details at the main panel points. Hitch angles, countersunk stitch rivets, longitudinal and transverse plate and angle diaphragms were used for the main end diagonals in a manner similar to the corresponding details in the 644-ft. span. The lower struts of the sway bracing were made particularly stiff, and required special hitch connections, as indicated.

The lift span to replace the drawbridge had been promised by the railroad company with the object of providing a clear channel for the full width of the canal. The greater proportion of all the water traffic is passed through this canal and not through the main channel of the river.



LIFT SPAN CAN BE RAISED 32.5 FEET IN 45 SECONDS

Lift Span Features—This span, 260 ft. long between centers of end bearings, is also of the riveted-truss type with triangular web system, and with curved upper chords. It can be lifted 32.5 ft. in 45 sec. The design of the lifting mechanism has certain modifications found from experience with the lift span of the Pennsylvania R.R. in Chicago to be advantageous, as follows: Chains with cast-iron links, as seen in one of the photographs, are swung from the towers to the bottom of the counterweight for counterbalancing the steel cables and maintaining balance for all positions of the span. An effective pneumatic cushioning device, which acted in connection with a centering device, was developed. In order to keep the lifting cables at fixed angles and prevent movement and consequent wear on the equalizer pins, cast-steel rope clamps were designed, held in position by high-strength steel links, providing for sixteen 2¼-in. cables to carry a total load of 660,000 lb., one quarter of the span weight.

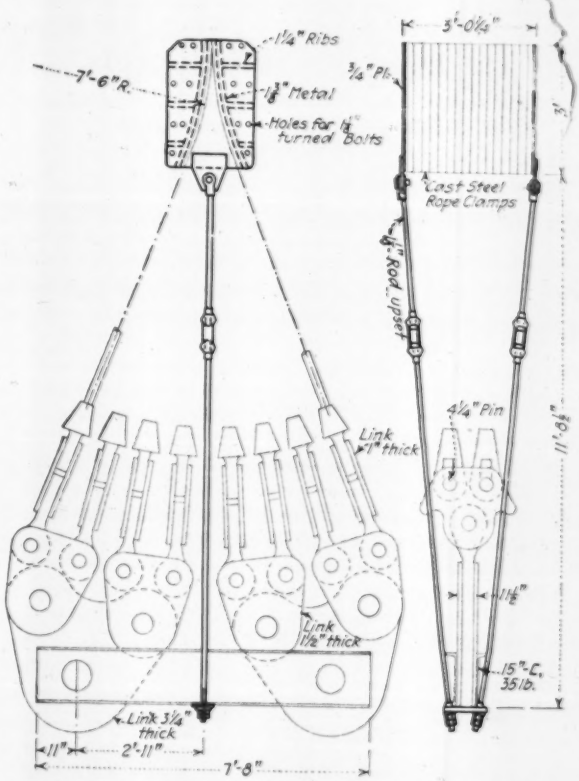
The counterweight sheaves, the heaviest yet constructed, are built up of steel plates, angles and castings. Each rim segment is fastened to the side plates by sufficient rivets to take the entire load coming upon it from the ropes. Between the segments ½-in. spaces were left, to avoid trouble if the lengths of the segments should overrun. Originally, it was intended to fill these spaces with hemp, but the cutting tools gave trouble when the machining of the grooves was begun, and it was necessary to fill them with babbitt. Trouble from bad fit of the side plates on the hub casting was eliminated by making the side plates bear directly on the shaft, instead of on the hub casting. The hole for the shaft was bored out after the sheave had been completely assembled and riveted. The hub is keyed to the shaft by three 1½ x 1-in. keys, secured from longitudinal movement by setscrews. The bearings are lined with phosphor-bronze bushings.

On account of the relatively large amount of play in the vertical guides, they do not center the span closely enough for the rail locks, which have very little play. Therefore a transverse centering casting, having small play, is placed at the middle of each end floor-beam. This is an improvement over the previous practice of using centering castings at each L_0 point, in which case considerable play had to be left in order to provide for expansion and contraction, and they did not center the span accurately enough for the locks.

To eliminate the jar when the span comes to a bearing, air buffers near each end of each of the end floor-beams were provided. Adjustable needle valves on the exhaust ports of these buffers permitted the variation of the resistance at will. Bridge locks were not used, but the counterweights were made about six tons lighter than the span, the excess weight of the latter overcoming any tendency for it to rise.

The towers are 105 ft. high from the top of the masonry to the center line of the 15-ft. main cable sheaves; the span when lifted 32 ft. gives a clear headroom of 79 ft. above the pool level of the canal. Provision was made in the detailing of the connections between floor-beams and vertical posts of the lift span to permit the former to be raised vertically if necessary, to provide for a change in grade of this approach over the canal. This was done because of the possibility of later grade-separation development in the City of Louisville.

J. C. Bland, engineer of bridges, Pennsylvania Lines West of Pittsburgh, personally designed the through-truss spans, and all details were developed under his supervision, using the standard specifications of the Pennsylvania Lines West. The contractor for the manufacture and erection of the entire bridge was the Pennsylvania Steel Co., which before the termination of the work was absorbed by the Bethlehem Steel Bridge Corporation. The erection was done under the supervision of W. W. Priest, assistant engineer of bridges, Pennsylvania Lines West. The mill and shop inspection, as also the field inspection, was in the hands of F. M. Masters, of Harrisburg.



ASSEMBLY OF EQUALIZERS AND ROPE CLAMPS—LIFT SPAN, LOUISVILLE BRIDGE

The work was begun and all contracts were made by the Louisville Bridge Co., the original owners, which company was succeeded by the Louisville Bridge & Terminal Co., a subsidiary of the Pennsylvania company, the present owners of the property.

Freight Distribution by Motor Trucks

Having 900,000 sq.ft. of warehouse storage capacity, closely connected with the terminals of the New York State Barge Canal, Callan Bros. of New York City, receive and distribute merchandise in that city and throughout New England, New Jersey, Delaware, Pennsylvania, and other seaboard states, by operating forty 7½-ton trucks on schedules indicated in the following table:

	Miles	Hours per Trip
New York to Philadelphia	100	12
New York to Baltimore	188	22
New York to Dover, Del	172	21
New York to Waterbury, Conn	95	11
New York to New Haven, Conn	77	9
New York to Bridgeport, Conn	58	8
New York to Hartford, Conn	113	16
New York to Springfield, Mass	139	18
New York to Worcester, Mass	190	23

Operation of Fine Sewage Screens at Long Beach, California

Tests Indicate That Screens Remove 16.3 Per Cent. of Solids—Screenings Incinerated by Gas—Operating Costs

EXPERIENCE with the Riensch-Wurl screens for more than two years at Long Beach, Calif., indicates that gas is cheaper than oil as a fuel to incinerate the screenings, that the screens need renewal after two to three years' use, that the average cost per 1,000,000 gal. has been $10.92, and that the installation has served its purpose of keeping the beach clean in an inoffensive manner.

A description of this 14-ft. screen with $\frac{1}{32}$-in. slotted holes, handling 2,600,000 gal. of domestic sewage of 22,000 persons appeared in the *Engineering News* of May 4, 1916, p. 836. The operation as described in a report by engineers of the state board of health is as follows:

The cans of screenings are hoisted by hand by means of a chain-and-gear-set suspended from a track on the roof, and emptied into the top of an incinerator. The incinerator is 7 x 15 ft. in plan, and 8 ft. high. It is of brick and is lined with firebrick. On the inside are three platforms, equally spaced one above the other, built of firebrick with openings about 1 in. wide between the rows of bricks in the two upper platforms so that they serve as grates. At one end of each of the upper platforms is a large opening through which heat and fumes may pass. These openings are at opposite ends of the platforms, so that the circulation is forward and back and forward again as the current travels downward and out toward the chimney. The screenings are placed on the top platform, where heat is applied in the form of burning gas blown in on top of the screenings together with a blast of air. Occasionally during the burning the screenings are raked over, which causes part of them, together with ashes, to drop through the grate openings onto the platform below.

Gas Substituted for Oil to Burn Screenings

Prior to April, 1917, oil was used as a fuel for incinerating. Natural gas was then substituted because it was easier to handle and cleaner. Also, with oil at present prices gas is more economical.

The volume of screenings is measured in the can whenever a can is emptied into the incinerator. The screenings have practically the same weight as water. An average of five hours a day is required for burning. The screenings of each 24 hours are all burned at once. About one wheelbarrowful of ashes is produced during each burning. For an estimated average flow of 2,600,000 gal. daily the screens removed about 70 cu.ft., with a moisture content of about 87%. Burning with oil required 0.8 gal. per cubic foot at a cost of 2.5c. The gas consumption was 81.4 cu.ft. per cubic foot of screenings, at a cost of 3.5 cents.

The electric power used averages about 75 kw.-hr. per day, of which about 55 kw. are used to operate the screening plant, and the remainder for pumping.

Under normal operation there is an almost complete absence of offensive odors. No indications of sewage are visible in the ocean. Around the outlet sea gulls are notably rare.

Some experiments carried on with composting screenings gave rise to slight odors in the immediate vicinity of the work. The experiment consisted of preparing a bed of sand 6 in. deep, placing over it 6 in. of screenings and then covering with 6 in. of sand. After a few days the entire volume of sand and screenings was spaded and mixed. Another experiment consisted of drying the sludge in a nearby fish canning plant used to dry fish offal. Analysis indicated a value of $35 per ton dry on the basis of $5 per ton per nitrogen unit.

After about two years' use the brass screen plates began to show wear. The brushes rub the plates in a line transverse to the slot openings, which probably facilitates rapid wear around the slots and also tends to hasten clogging. It is intended to try out a new type of plate in which the slots will be sawed along the line of travel of the brushes on their upward sweep. The brushes are renewed twice a year at a cost of $44 a set.

Tests to Determine Work of Screens

Tests made in May, 1916, on eight composite consecutive samples, each sample representing about 2½-hour periods in one-half-hourly portions taken from 10:15 a.m. to 4 p.m. the next day, gave an average removal of 43.5% with a minimum of 10% and a maximum of 62.7%, as indicated by settleable suspended matter. At the time the test was made the 50-cc. samples dried and weighed in the Gooch crucible did not give very dependable results. The amount used was so small that it appeared a large error crept into the results. Some of the screened samples tested in this manner showed a higher residue than the raw sewage, which condition is accounted for more by the inability to obtain fairly average samples of raw sewage than by inefficient screening. The test was not considered very satisfactory.

Later tests were made in 1918, under the direction of W. J. Knowlton of the Los Angeles sewer department, by J. W. Geeks, head of the substructure department. The following notes are abstracted from his report:

No odor was noticeable 200 ft. from the plant. When the fire is drawn from the incinerator the incompletely consumed ash is the greatest source of odor, but the ash is quickly disposed of.

Samples to determine the amount of solids removed were taken below the screen rather than above, because of the more uniform character of the effluent. Above the screen representative sampling was impossible because of the heavy flow of solid matter on the invert moving at a slow rate. A sample 4 x 4 in. in cross-section was taken, extending from the surface to the invert, but this, compared with samples taken at and below the screen, showed a ridiculously large amount of solid matter.

Two-gallon samples were collected every hour and placed in a 7-cu.ft. sludge can. After they had settled 20 hours the clear water was siphoned off and the resi-

OPERATING EXPENSES PER MILLION GALLONS

Fuel oil	$0.700
Fuel gas	0.909
Electric power	0.868
Electric lighting	0.128
Salaries	2.690
Supplies	0.359
Repairs	0.213
Office overhead	0.383
Interest at 5% on investment	2.097
Depreciation	2.574
	$10.921

due was collected and weighed, when the moisture was judged to be the same as that of the screenings. Proper corrections were made for variation of quantity of flow and of "density"—i.e., the relation of the flow of the sludge to the flow of sewage. Dried samples indicated that the error in the method was within 6% of being correct.

Data obtained May 7, 13 and 14, and on Jan. 3 and 4, 1918, when the average, maximum and minimum daily rates were 2.6, 3.9 and 1.5 million gallons, indicated 1810 lb. per 1,000,000 gal. removed, equivalent to 16.2 per cent.

Unit costs based on a period between Mar. 31, 1917, and Apr. 28, 1918, from records kept by Charles B. Murphy, superintendent, are given by Mr. Geek as shown by the accompanying table.

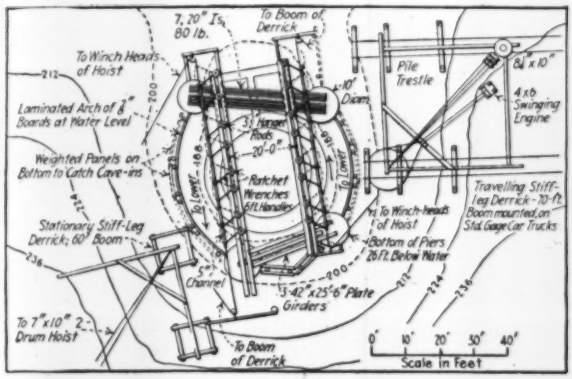
The investment per 1000 population within the sewered district is $181.80, and the yearly operating cost per each thousand of the city's population is $181.20.

Sinking a Concrete Pumping Station in a River

House Consisting of Concrete Cylinder 30 Feet in Diameter Is Lowered While Being Built From Frame Controlled by Ratchet Wrenches Tied Together for Simultaneous Movement

By KEITH O. GUTHRIE
Engineering Contractor, Schenectady, N. Y.

FEED and condensing water for the General Electric Co.'s Schenectady, N. Y., plant is now supplied from an abandoned stretch of the Erie Canal maintained at level from a new pumping station on the nearby Mohawk River. The main house for this station, a cylindrical concrete shaft, was built in the severe winter of 1917-18 by a novel method. Temporary piers were sunk around the site, and on them, as foundations, a platform forming the bottom of the house was hung by rods, which were controlled by wrenches tied together so as to permit simultaneous operation. The house was then built up on this platform, and was lowered as the walls progressed in height.


To Boom of Derrick
To Winch Heads of Hoist
Laminated Arch of 8" Boards at Water Level
Weighted Panels on Bottom to Catch Cave-ins
Stationary Stiff-Leg Derrick; 60' Boom
To 7"x10" 2-Drum Hoist
Pile Trestle
4x6 Swinging Engine
Ratchet Wrenches 6 Ft. Handles
To Winch-heads of Hoist
Bottom of Piers 28 Ft. Below Water
Travelling Stiff-Leg Derrick - 70-Ft. Boom mounted on Std. Gage Car Trucks
Channel
3-40"x25"-6" Plate Girders
To Boom of Derrick
Scale in Feet

LAYOUT OF PLANT AND STRUCTURE USED IN SINKING CONCRETE CYLINDER PUMPING STRUCTURE

The station is located between the river and the canal where the river bank is only 80 ft. from the towpath and on the outside of a bend in the river, making it likely that the current would make the intake free from silt. It is in the water, the contours of the bottom running around 188 where 212 is the normal shore line. The pump-room floor is 15½ ft. below normal summer river level and about 40 ft. below record stage. The material at the site is a compact, coarse, water-bearing gravel, unsuited to any kind of cofferdam.

At the start of the work a 2½-yd. dipper dredge made 16 ft. of water over the site of the house and for about 20 ft. around it. The spoil was removed in scows. At the same time, stiffleg derricks were erected on either side of the cut; these operated 1¼-yd. clamshells and completed the excavation to 24 ft. below water level.

When excavation had been roughly completed, four piers were built around the location of the house, as shown in one of the drawings. The forms for these piers were round barrels, of 10-ft. inside diameter, and 30 ft. long, with outside ribs of 2 x 10-in. plank lapped and well spiked. To provide a cutting edge and also weight for sinking, a reinforced-concrete ring was attached to the bottom of each form. The complete form units weighed about eight tons, and were set in place by the derricks and guyed. It was desired to have these piers extend at least 2 ft. below the grade

LOWERING FORM FOR SUPPORTING PIER INTO MOHAWK RIVER

of the excavation for the house, so as to secure the full bearing power of the gravel. The forms were sunk quite readily by excavating inside them with the clam-shell. As soon as a form reached grade, nine 45-ft.

CONCRETE BEING PLACED AT SAME TIME HOUSE IS LOWERED

piles were driven inside with a five-ton steam-hammer to practical refusal, which came at from 15- to 20-ft. penetration. Concrete was then placed by tremie, and the piers were brought to 9 ft. above water and capped with a grillage of old rails.

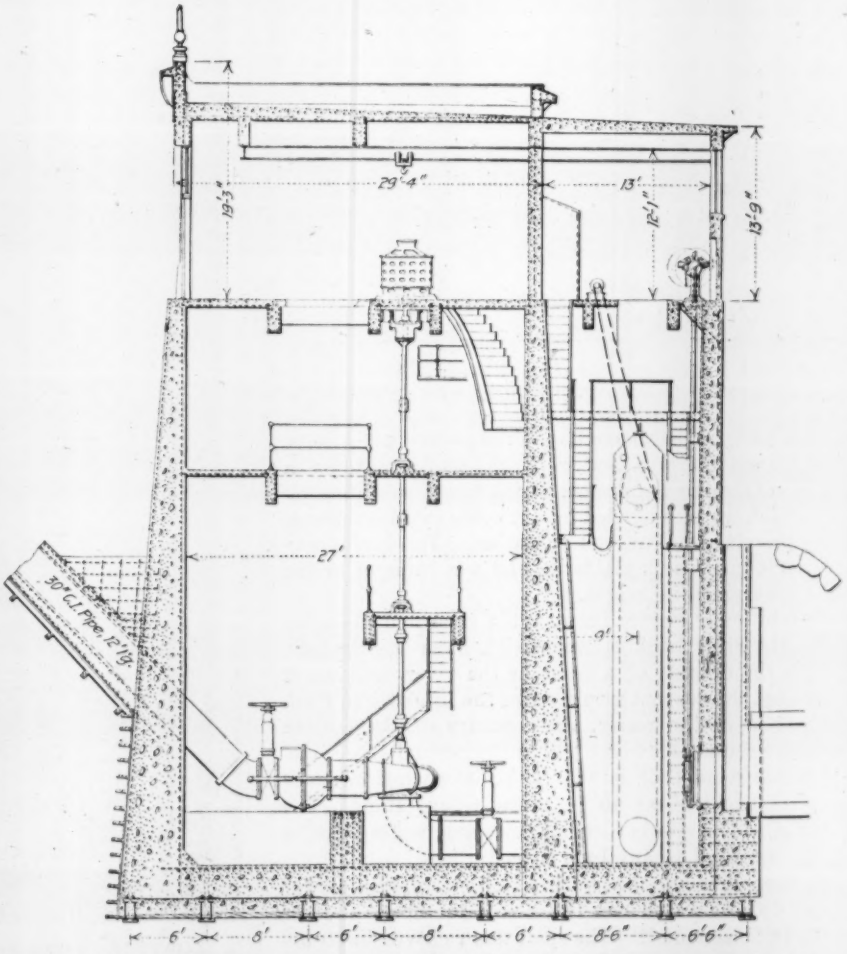
The two inshore piers were then bridged by three 42-in. plate-girders, and the two outshore piers by eight 20-in. 80-lb. I-beams. Both the girders and the I-beams were girdled with heavy clamps, and the space between the webs was filled with concrete from pier to pier, to resist lateral buckling under load. In addition, the girders and beams were securely anchored into the pier tops, to minimize the danger of any pier leaning.

Seated on the cross-beams and the cross-girders were two pairs of heavy plate-girders, from which hung the suspender rods that carried the house itself. The girders of each pair were spaced with the flanges just far enough apart to pass the connecting sleeve-nuts of the rods. The girder pairs were spaced on 20-ft. centers. Pains were taken to give the main girders evenly distributed bearing as well as an anchorage to the beams and cross-girders on which they were seated. The girders of one pair were 6 ft. deep by 58 ft. long, of the other pair 7 ft. deep by 67 ft. long. Both sets were built to Cooper's E-50 specifications and were bought from the American Bridge Co. out of a bridge built for a railway project that was abandoned.

To secure maximum supporting power from the main girders, they were cantilevered at the screen-well end for about 12 ft., giving roughly the same bending moment at the outshore piers as at the middle of the long span.

Eight 3½-in. V-threaded rods were hung from the top flanges of each pair of girders. At each rod the girders were bridged with a pair of 10-in. 30-lb. channels on which rested the washer carrying the lowering nut. To obviate the danger of the nut cutting under a load of at least 30 tons and possibly much more, the washers were made of two 1½-in. plates, of 16-in. diameter, with the faces in contact faced, oil-grooved in opposite directions, and packed in light grease.

The lowering nuts were 12 in. long, of standard hexagon section, and were engaged by ratchet wrenches with 6-ft. handles, as shown in the views. The ends of the wrench handles were bolted to 5-in. channels, one on either side of the house. Lines ran from each end of the channels to derrick hoists seated on temporary trestles outside the house area. These lines operated the wrenches back and forth in unison, each movement giving the nuts one-sixth turn. Electric door-switches, engaged by the moving channels, rang bells in the engine-rooms to indicate to the hoist-runners the limits of the stroke.



VERTICAL SECTION THROUGH PUMPING STATION SHOWING ALSO DETAILS OF SUPPORTING FLOOR

Opposite rods supported pairs of 15-in. I-beams which formed a floor under the entire house. As erected, these beams just reached the water. They were tied together with ¾-in. tie-rods, on 4-ft. spacing, and separated by a 4-in. wooden floor resting on the bottom flanges. After the first ring of the outside forms was set, resting directly on the floor-beams, a subfloor of concrete was placed, covering the top flanges 2 in. and with an 18-in. fillet at the outside form. On this subfloor and up the outside forms were laid five layers of patent roofing felt very thoroughly mopped with waterproofing pitch. This work was done by Craig & Vrooman, of Schenectady. The reinforcement, inside wall forms, and forms for the inverted floor-beams were then placed and concreted. The house was lowered at the same time, keeping the level of the concrete about 1 ft. out of the water. The best progress in lowering at any time was 15 in. in an hour.

The outside forms were built 1 ft. higher than the inside, to provide a lap for the waterproofing of the succeeding lift. No difficulty was experienced in lowering

OPERATING WRENCHES ON ONE SIDE TIED TOGETHER FOR SIMULTANEOUS OPERATION

fresh concrete into the water. Frequently, concrete in the walls an hour old was under water—amply protected by the five-ply waterproofing. This waterproofing passed a remarkable test one night when a thaw up the valley caused a sudden rise in the river. Before a gang could be brought out from the city and concreting

CLOSE VIEW OF ONE OF THE RATCHET WRENCHES

started, the water level was 20 in. above the concrete in the walls, and at one point 3 ft. There was not so much as a drop of leakage through the outside forms. While it has been customary to place such waterproofing against such a masonry wall, this was dispensed with on the work, to save time and expense. It is believed that the wooden forms—always under water—will prove a permanent protection.

It was felt in advance that the chief danger in this method of lowering a heavy structure lay in the possible settlement of one of the piers. It was conceivable that a material relative settlement of one pier would concentrate the entire weight on a few rods, overloading and even snapping them, with consequent disaster. To guard against this possibility, a great deal of care was taken with the piling and concreting of each pier. The rods were made heavier than required for even loading, and the subfloor, on which the house proper was built, was made flexible in one direction. The first pour of the house, including the floor and a portion of the walls, weighed about 600 tons. This was cast without being lowered into the water, with the idea that this entire load would be likely to bring about immediate and maximum settlement and, being fairly flexible up to this point, would adjust itself to any relative settlement of the piers. As it developed, however, there was no observable settlement in any pier.

A further fear was entertained that, through unequal running off of the lowering nuts, some of the rods might be overloaded. Considerable thought was given to the application of strain-gages, but it was soon found that an underloaded rod shifted on its support as the heavy wrench swung back and forth, while an overload rod groaned. A one-sixth turn of the nut—about $\frac{1}{10}$ in. on the rod—was usually sufficient to equalize the loading.

The hanging equipment went through a very severe test in the early part of February. The house had been lowered 16 ft. into the water, a set of forms made ready for a new pour, and the entire structure covered with a board house as protection against the severe cold. A fire, started presumably by a salamander, consumed forms, runways, and protection housing, to the water edge. The girder webs were badly buckled and one girder sagged 2 in., but, after the forms were made good, the lowering was resumed without any difficulty except in lubricating the lowering nuts.

The method of construction was developed by the writer, and the station design was worked out by him in consultation with A. W. Nesbit, superintendent of

power, and C. G. Hulth, superintendent of grounds and buildings, of the General Electric Co. W. R. Abbott acted as construction engineer and James J. Fahey as superintendent.

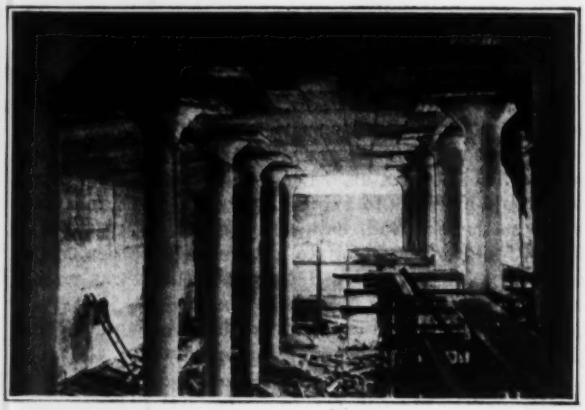
Flat Slab Substituted for Groined Roof of Reservoir

Money Saved in Dayton Water-Works Structure Due to Less Concrete and Excavation and Simpler Forms

By H. C. Wight
Superintendent, Division of Water, Dayton, Ohio

GROINED arch roofs have been the practice in concrete flat-top reservoirs for a number of years. Only occasionally has another type of design been utilized. In the recently completed reservoir for the water-works of the City of Dayton a flat-slab reinforced-concrete roof was substituted for the groined roof originally designed and it is the opinion of the engineers that this revision, together with a lower amount of excavation required in the new design, resulted in a considerable saving to the city.

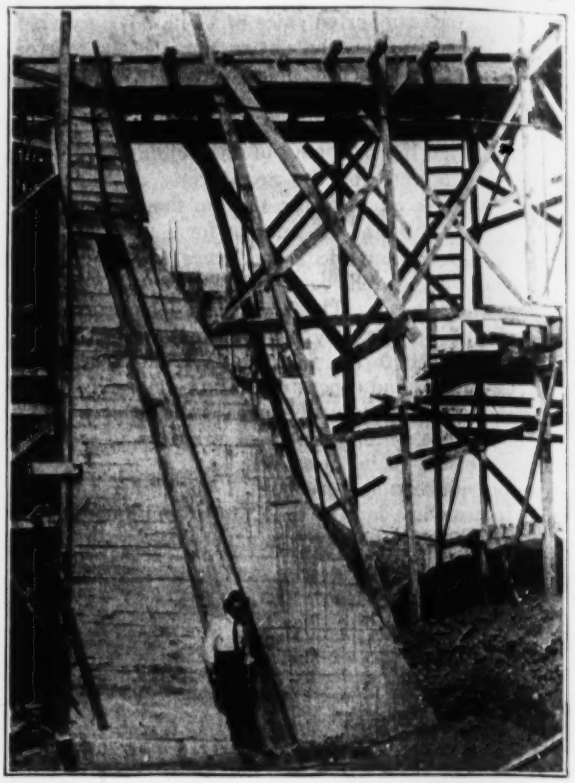
An additional water-supply for the city has been under way for about five years. One of the main improvements, planned in 1917 and completed last autumn, had a capacity of 10,000,000 gal. It is located in the hills to the south of the city, on a site of about four acres. It is in a flat-top reinforced-concrete structure sunk about half its depth in the original surface and covered over with 2 ft. of loam to keep the water cool and to prevent freezing.



INSIDE OF DAYTON RESERVOIR JUST AFTER FORMS WERE STRIPPED

The contract was first offered July 31, 1917, at which time bids were received on the groined-arch type of construction. These bids were rejected on account of their being excessive. Apparently, the contractors were afraid of the groined arch on account of the complicated form carpenter work required and the shortage in that war year of carpenters. Accordingly, a second design was made, and alternate bids were opened Sept. 17 of that year for the groined arch and the new flat-slab type.

These bids were rejected on account of a technicality and a third letting on the same types occurred on Oct. 5. Contractors in this letting were allowed to submit alternate designs and bids, and the award was made on the flat-slab design at an amount about $60,000 less than the lowest bid in the first letting and $10,000 less than the lowest groined-arch bid in the last letting. The unit prices on this low-groined arch bid, however, were considerably lower than the bid accepted, and it is doubtful if the margin of profit for the contractor would have been as large.



HEAVY GRAVITY CONCRETE WALL FORMS SIDE OF FLAT-SLAB TOPPED RESERVOIR

The design accepted was submitted by the contractor, the Danis-Hunt Co. of Dayton, Ohio, and was prepared by Nelson J. Bell, engineer with Schenk & Williams, architects, of Dayton, Ohio. The savings in this design are due to three things: The formwork, the excavation and the concrete.

At this time lumber was very hard to get, owing to the heavy demand. The flat-slab roof design was much simpler, so far as formwork went, and the lumber was used actually some three times with a very small amount of cutting.

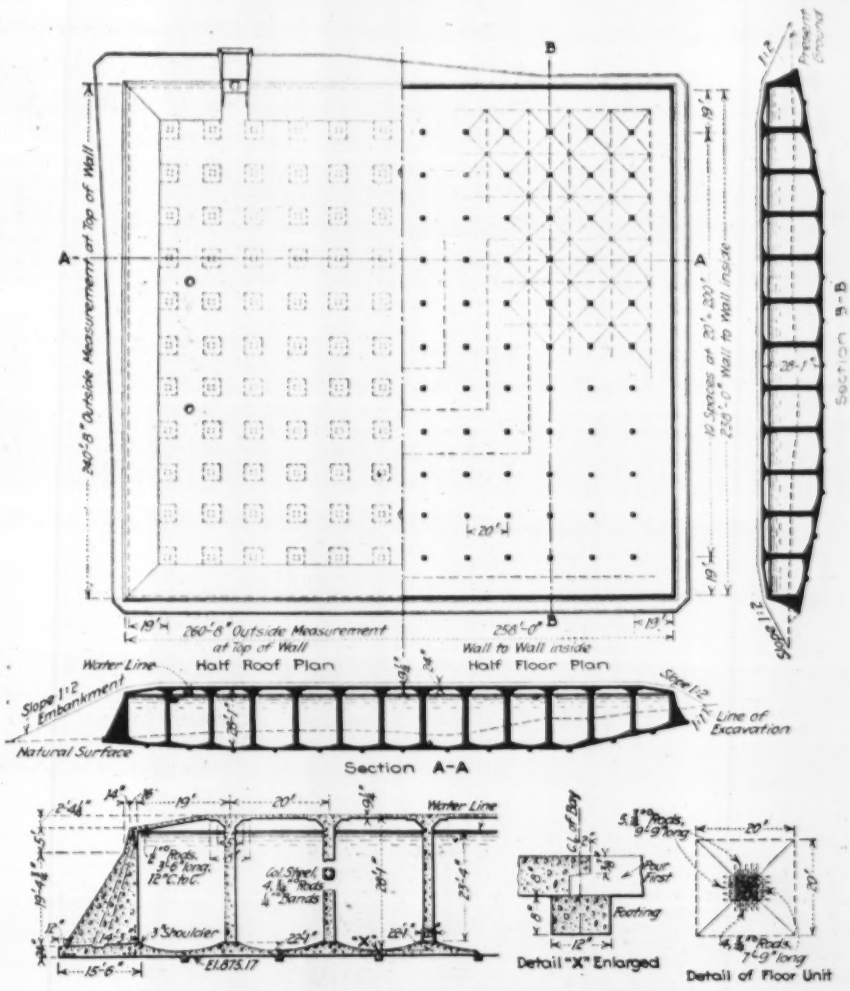
The class of saw-and-hatchet men available could handle the work with reasonable speed. In excavation, the fact that the new design utilized a bottom slope, as shown in the drawing, saved some 7000 cu.yd., about 26,000 yd. of dirt being handled as compared with the 32,700 that were estimated for the straight-bottom groined arch.

This would have been more had the reservoir been located on level ground instead of on the side of a gradual slope.

The third saving effected in the concrete is due to the fact that the groined arch required 8820 cu.yd., as compared with 7902 cu.yd. for the flat slab. However, in the actual construction the roof was increased from

8 in. to 9.25 in., so somewhat more concrete was used. The final payment was $136,760, as against the bid of $133,934, which compares with the $193,412 bid on the first groined arch.

General details of the reservoir are shown in the accompanying drawing. As will be seen, it has a groined-arch floor with gravity side walls retaining the embank ment and a flat-slab roof sup ported on columns on 20-ft. centers, footing on the rise of the floor groins. The bottom is sloped up on all sides for reasons of economy, as stated. The retaining walls, as shown, are built separate from the floor with a dap joint there and at the vertical construction joints. The groined-arch floor is also designed to be laid in square sections with expansion joints, as s h o w n in the details. Under each joint there is a concrete block 12 in. square by 8 in. thick. There has been no leakage through these joints to speak of. The only place water-proofing or asphaltum w a s used was in the roof, over the joints there. The reservoir was designed and constructed under the direction of J. E. Barlow, director, Department of Public Service, with the writer as superintendent of the Water Division. Leonard Metcalf, Boston, was consulting engineer.



RESERVOIR HAS FLAT-SLAB REINFORCED-CONCRETE ROOF

Speed and List in Side Launching of Ohio River Boat

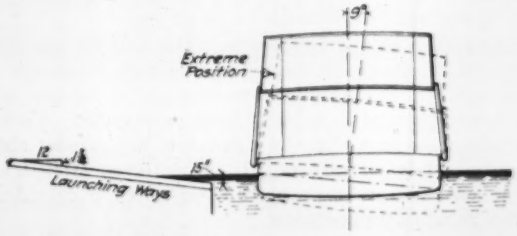
AT THE launching of the stern-wheel river towboat "Warren Elsey" at Neville Island, near Pittsburgh, Mar. 29, engineers for the Dravo Contracting Co. of Pittsburgh, the builder, made observations of the behavior of the vessel during the launch.

Briefly, they found that the boat was moving at a speed of 16 ft. per second when she left the ways, which were laid on a slope of 1¾ in. in 12. Upon striking the water the boat listed 9°, as determined by a glass U-tube, with legs spaced 3 ft., half filled with thin paint; an attempt to measure the list by a pendulum consisting of a 10-lb. weight on a 24-in. arm was unsatisfactory. On recovery the boat listed 5° in the opposite direction. At the time of dropping from the ways it dipped 18 in. lower at the stern than after it came to rest, presumably because of the inertia of the machinery. The boat moved square to the ways, dropping off with not over 6 in. lead of one end over the other, as determined by two observers sighting past range poles.

An unusual feature of this launching, for Ohio River practice, was that the boat was practically complete, all equipment having been installed on the ways, including engines, boilers and stern wheel. Its launching weight was 367 tons, corresponding to a draft of 2 ft. 8¾ in. forward and 4 ft. 3¾ in. aft.

The boat itself is of steel, but the crew's quarters on the upper deck are of wood. Its length over all is 162 ft., and the length of the hull 137 ft. 5 in.; its beam is 27 ft. and its depth 6½ ft. It carries a wheel 20 ft. in diameter by 18½ ft. long. Power is furnished by tandem-compound engines 14 and 30 in. by 72 inches.

The vessel was carried on four pairs of launching cradles equally spaced. Of these the stern cradle carried the heaviest load, 111 tons, equivalent to 4.1 tons per square foot on the sliding surface. As indicated in the sketch herewith, the water ends of the ways are submerged 15 in. The ways rest on concrete piers except at the outer ends.



LAUNCHING SKETCH FOR STERN-WHEEL BOAT

Concrete Used to Patch Worn Brick Paving

Old Surfacings, Broken Up by Excessive Loads, Have Been Successfully Repaired by this Method in Cuyahoga County, Ohio

PATCHING with concrete is the method used to repair some of the older, brick-paved roads in Cuyahoga County, Ohio. The patches vary in size from small areas to those covering 400 to 500 sq.ft. Repairs of this kind were made on a road leading west from Cleveland, where the brick paving had been partly broken up, due to its light construction, by dense traffic, consisting largely of heavy loads for the American Shipbuilding Company's plant at Lorain, Ohio. The repairs are shown in the accompanying views.

The brick surface, which was placed some years ago, rests on a 2-in. sand cushion over a 6-in. base of rolled

CONCRETE PATCH BEING MADE ON WORN BRICK HIGHWAY IN CUYAHOGA COUNTY, OHIO

slag. While unsuited for the heavy traffic it is now called upon to carry, reconstruction was out of the question during the war, so that the best method available had to be used to keep it in serviceable condition. Experiments were first made by repairing the broken parts with crushed stone and cut-back bitumen, but this type of patch did not give satisfactory results. Concrete was then tried, and has proved successful.

All worn and broken brick are removed, the projecting halves of alternate brick being broken off, so that a vertical base is provided. The old base is dug out, and the subgrade is tamped. A new base of 1:2½:5 concrete is then placed, using crushed slag for the coarse aggregate. On this is laid a 2-in. wearing course of 1:1:2 concrete made with crushed granite ¼ to ¾ in. in size as the coarse aggregate. The patches are from 10 to 12 in. in thickness. The concrete is struck off level with the surrounding pavement and is finished with a concrete pavement roller, where practicable. Care is taken to make sure that the patch does not project above the adjacent brick surface. It is protected from traffic for at least two weeks, a precaution which is considered of the greatest importance.

COMPLETED CONCRETE PATCHES IN BRICK ROAD

The work is done by a maintenance gang, using materials which have been distributed along the road in the required quantities. The concrete is mixed by hand for the smaller patches and a small mixer is used for the more extensive repairs. Where patches extend more than half across the pavement the surface is reconstructed in sections so that traffic will be hindered as little as possible.

The work is carried out under the direction of J. F. Gannon, superintendent of road repairs for Cuyahoga County.

Fire-Service Connections Menace Pure Water Supply of Cities

THE relation between domestic and fire supplies of water in small towns received careful consideration at the recent meeting of the Minnesota Section of the American Water-Works Association, at Minneapolis. That the state board of health, which must pass on all plans for small cities, has had considerable trouble in correcting some undesirable conditions was shown in a discussion of the dangers of polluting a public water-supply by means of private fire-supply connections, following papers on "Water-Works as Fire Protection," by H. F. Blomquist, of St. Paul, and "Features of Design in Small Water-Works" by F. H. Bass, of Minneapolis. A resolution was passed requesting the parent association to appoint a committee to secure standard practice and coöperative action in order to combine fire protection and sanitary conditions, with a view to placing these features under local or state control.

That legal responsibility for pure water rests on the municipal officials is indicated by the decision in the Mankato case, according to a paper by John Wilson, of Duluth. This case arose from sewage pollution of the artesian supply, due to floods in the Minnesota River in 1908.

Mr. Wilson pointed out that fire supplies planned to supplement the municipal supply are responsible for any contamination due to such supplementary supply. A resolution was passed opposing the use of cross-connections between a polluted fire supply and a pure or purified public supply. This resolution also commended the state board of health for its work along these lines.

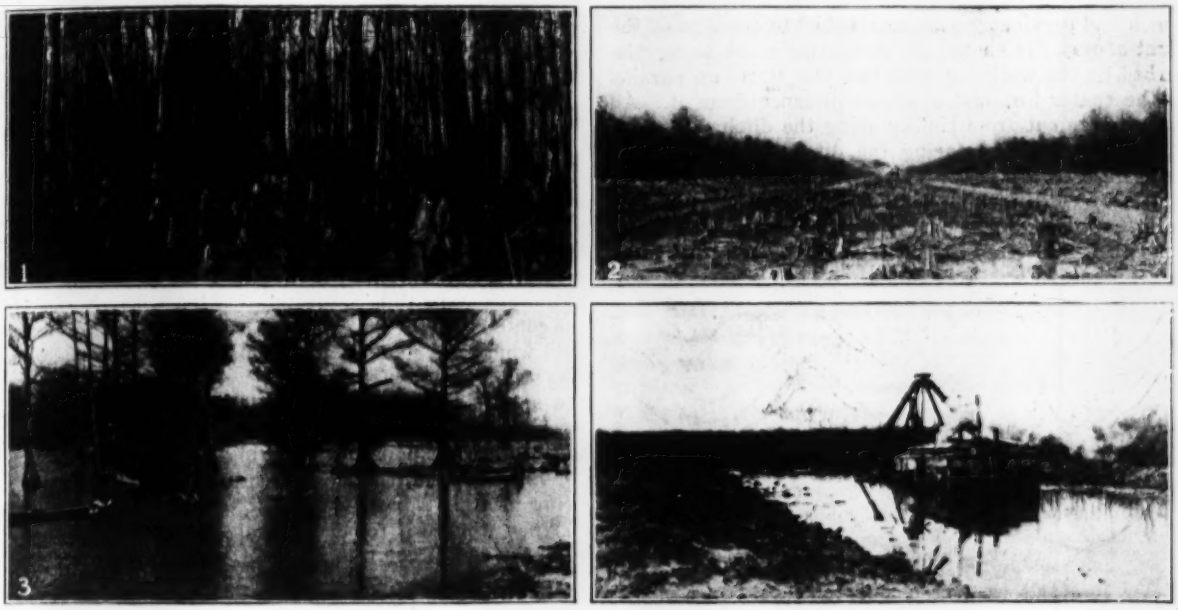
Inspection of Drainage Ditch Cross-Sections After Contract Dredging

Soundings First Made by Level Rod Gave Way to Lead and Line Following Along Tape—Boat Used by Sounding Man Was Pulled Across by Means of Tape

By E. S. Blaine
Engineer, Residency No. 4, Little River Drainage District, Kennett, Mo.

NEARLY 650 miles of floating dipper dredge work has been completed by the Little River Drainage District in southeastern Missouri. Previous to the legislation which made this district possible, the jurisdiction of a drainage district in this state was limited to one county. The engineering work was usually done by the county surveyor. We have been unable to hear of a case where the ditch was cross-sectioned behind the dredge. The "inspection" was usually done by rowing along the center of the ditch, or riding along it in a motorboat and sounding with a pole at more or less frequent intervals, depending upon the speed of the boat. Too often even this "formality" was dispensed with. The work was then accepted by the "engineer." As it was desired not to accept work when no more was known about its actual condition than such meager data would permit, a set of "Instructions for Resident Engineers" in this district was issued, outlining methods for inspection. The outline was added to, or revised, as improvements developed. This article tells of the methods that have been used and explains their development.

The size of the ditches varies from 4-ft. bottom and average depth of 8 ft. to 123-ft. bottom and average depth of 11 ft. All ditches have 1 to 1 slopes specified. The land within the district has a surface so nearly a plane that it was considered an unnecessary refinement to cross-section the natural surface, except in special cases where an old channel was appropriated, or where a large river crossing or some local irregularity of considerable magnitude made such cross-sections necessary. Levels were run along the center line and benchmarks set approximately one-fourth mile apart. The cut at each station, description of benchmarks and alignment notes were all placed on the profile. Tables were made for the different base widths, giving the quantities of excavation, for level sections, in a prism 100 ft. long, at 0.1-ft. intervals. For estimating the yardage, the quantities were taken from the tables for the center cuts written on the profile.



FIGS. 1 TO 4. PROGRESS VIEWS ON DITCH NO. 1, LITTLE RIVER DRAINAGE DISTRICT, MISSOURI
1. Cypress and tupelo timber along ditch line. 2. Looking up the pilot cuts. 3. Setting slope stakes; note man and boat on either side. 4. A 4½-yard dredge at work.

After the excavation, cross-sections were taken at each station on all the ditches. These cross-sections were used for computing the yardage in special instances only, as follows: River crossings and other local irregularities in the natural surface; pilot cuts where part of the prism was excavated; reaches where it was necessary to excavate below ditch grade to get material for raising spoil-bank levees to an established grade; where the work consisted of improving an existing channel. The rest of the cross-sections were taken for the purpose of insuring the removal of all the material in the specified prism. At times it was necessary to take as many as four sets of cross-sections before the ditch was brought to grade.

As the excavation was under water at all times, the cross-sections were taken by means of sounding from the water surface along a tape stretched across the ditch. It was not practicable to pick out the irregularities and limit the number of readings by the governing points, as is done where the work is visible, so soundings were taken at regular intervals. For the small ditches, the interval was 3 ft., except that a reading was taken 2 ft. from each bank to show up better the actual slope being excavated. On the large ditches the soundings were taken at intervals of 3 ft. on each slope and 5 ft. across the bottom.

The inspection of a reach of ditch would proceed in the following order: On arrival at the work, if on one of the smaller ditches, the chaining was picked up, preferably ahead of the dredge or from a reference point on one side, and the chaining was connected up with previous work. If on the larger ditches, points were located on the spoil bank from reference points which had previously been established to one side of the right-of-way far enough to insure their not being disturbed by the work. A base line was then run parallel to the center line and a known distance from it. All stakes were cut from timber along the ditch, and were marked on the side facing the ditch, to permit their being read from a boat. This saved a great deal of time and labor when looking for a bench mark or reference point, as most of the moving from point to point was done in boats. Due to openings in the spoil banks at

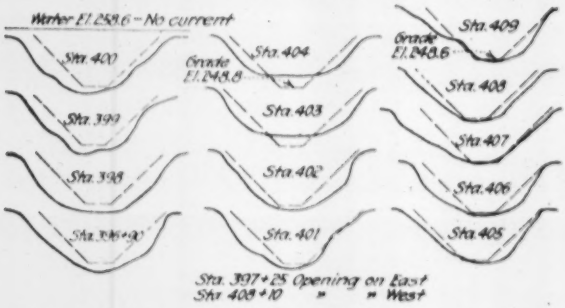


FIG. 5. SAMPLE OF DITCH CROSS-SECTION NOTES

intervals of 1000 ft., it was seldom possible to walk very far along the spoil banks without getting wet to the waist, as the openings usually had too much water in them for wading in hip boots, and we only used wading pants or "waders" when absolutely necessary and never in preference to a duck boat or dugout. After a few trials at walking along a new dump thrown up by a dipper dredge working in gumbo or clay one soon learns to use that route only when absolutely necessary to accomplish a definite object. It might be asked why the berms were not available for our work. This was due to their being under from 1 to 4 ft. of water for at least a mile behind the dredge, and they had a surface profile much resembling, on a large scale, the teeth in a crosscut saw. This irregular surface was caused by the spud feet, or anchor feet, as all but four of the dredges used bank spuds. The spuds left depressions 2 to 4 ft. deep each time the dredge moved up. The surface of the berm was further roughened by the dipper when scraping loose stumps and roll from it.

After the ditch was chained, the elevation of the water surface was found and a gage set near the dredge, giving the cut from water surface to grade line. At least two benchmarks were used in finding this elevation. Where there was an appreciable current in the ditch, the elevation was taken at each end of the reach, and where the reach was long and had diversions into old channels intermediate elevations were necessary. A Chicago tape was then stretched across the ditch. The recorder handled the chain on one side while the chainman held the other end on the opposite bank and the rodman did the sounding from a boat which he pulled across by means of the tape. Three men were used for most of the work, but some of it was done with only two, and where the current or the wind was too strong to permit the boat being held in line by means of tension on the chain, a fourth man was necessary to row or paddle the boat. To standardize the work, the zero end of the tape was always placed on the east or south side of the ditch. The recorder also noted the visible defects, such as logs and loose stumps, on the berms or in the openings; loosened or overhanging stumps in the edges of the ditch; trees leaning toward the ditch and high stumps on the berms which had been overlooked or were inaccessible when clearing was accepted.

On the small ditches a piece of light rope was fastened to the zero end of the chain. The rodman would sound until he found the edge of the ditch and direct the shifting of the chain until the zero end was located at this point where the recorder would fasten it by means of a lining rod, set through a loop in the rope, into the slope of the spoil bank. On the larger ditches the zero end of the chain was placed on the base line and the soundings were thus accurately located with respect to the center line. When cross-sections were taken on pilot cuts where the spoil had all been placed on one side, it was usually necessary for the man holding the tape, on the side having no spoil bank, to wear waders if the weather was cold, and sometimes the cross-sections had to be located at points where a high place was available for him to stand, the move from one point to the next being made in a boat.

When work was found to be above grade or too narrow, the contractor was required to correct it, and another set of cross-sections was taken.

METHOD OF RECORDING

During the early part of the work the cross-section notes were recorded in the usual manner, the soundings replacing the rod readings and the elevation of the water surface replacing the usual H. I. The reductions to sea-level datum were then made by subtracting the soundings from the elevation of the water surface, and the cross-sections were plotted and inked in. These sheets were sent to the main office, where blueprints were made, and returned to the resident engineer, who then issued orders for any necessary correction and mailed copy of the order and blueprint of the cross-sections to the contractor. As each engineer had supervision over the work of about nine dredges during the peak of the construction work, at least four of them averaging from one to two miles per month, the office work consumed time needed badly in the field, while the total time necessary to get the prints back to the contractor was still more important where the work was on small ditches. It took from one-half to one day to reach a dredge from a postoffice and it usually required a lot of difficult "hiking," wading and a long motorboat or "duck-boat" ride; so, due to the difficulty in reaching the dredge, the contractor rarely received mail more often than once a week.

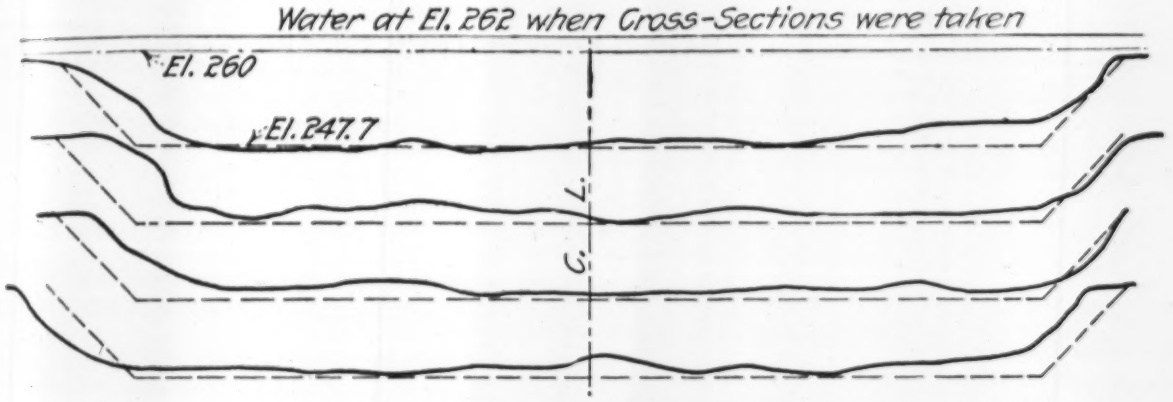


FIG. 6. CROSS-SECTIONS OF DITCH NO. 1 AS SPECIFIED AND AS FIRST LEFT BY DREDGER

The contractor supposed that the work was properly done. The example shows the need of a base line to obtain proper alignment when bringing ditch to grade. This ditch has a base width of 123 feet.

By the time the order reached him the dredge would be about a mile from the work requiring correction.

An improvement in the method of recording the notes was suggested. It received a trial and was found practicable for the small ditches where the need for a quicker method was so apparent in order to cut down delay in "kicking back." This delay was serious at times where it caused the recrossing of a river or slough which had a swift current flowing out of, or across the ditch. The method involved the use of specially made up blocks, or tablets, of cross-section paper held in a suitable stiff-backed cover. The tablets were of letter size, composed of thin paper ruled each way into ten divisions to the inch, with every third sheet blank or unruled. Instead of giving the heavy lines an even sea-level elevation, the heavy line was used as the water surface and the soundings were plotted down from them as the rodman called them off. Three copies were made by the use of carbon paper and a hard pencil in plotting. The distance from the water surface to the grade line was computed and marked on each section. Templets having the specified slope and bottom width, to a scale of 10 ft. per inch, were cut from thin celluloid. The proper templet would be laid on the section, centrally located with respect to the section as excavated, and with its base coinciding with the grade point. The theoretical prism was then drawn in and the amount of material, if any, inside the specified lines would be indicated. The order was then written and delivered to the contractor, along with the unruled copy of the cross-sections, before the work was left. The second copy was kept in the resident engineer's file, and the original was inked in and mailed to the chief engineer. The elevation of the water at the time the sections were taken was recorded on the sheet so that they could be referred to sea-level datum if desired. When the method was proposed it was feared that tablets bound so that the ruling would coincide would involve an excessive expenditure, but no difficulty was encountered in procuring tablets of this size, bound in this manner, at a reasonable cost. A "Lyflat Holder," sold by Buxton & Skinner of St. Louis, was used as a clip for the tablets in the field. Fig. 5 is a sample sheet of notes recorded in this manner.

On the larger ditches the work progressed more slowly in distance covered, and the need for quick service was not so much felt. The handling, in the field, of a book large enough to permit the plotting of sections having a top width of 150 ft. would be somewhat difficult, so no tablets were made for this class of work. The notes were recorded in a notebook, reduced to sea-level datum, and platted in the office. On these ditches the cross-sections were taken from a base line parallel to the center line. While this was not considered absolutely necessary, except when the cross-sections were used to compute the quantities, it was the means of settling several arguments due to the dredge operator on the night shift "getting lost" and departing badly from the line, and also permitted us to secure a better alignment when sections showed the excavated prism to be too narrow. Fig. 6 illustrates an extreme but actual case of this kind. With the sections referred to a base line, it was at once apparent which side should be widened, while without the base-line control it was impossible to tell this unless the water was low and the contraction of considerable magnitude.

Sounding Line Used

During the early stages of the work the sounding was done with a level rod, but the disadvantages connected with its use were so numerous that other means were tried until a satisfactory one was found.

The soundings often ran as deep as 15 ft., and in an extreme case 22 ft. A level rod was useless at these depths. Even at depths up to 8 ft. it was extremely tiresome to work with even a very light rod made for the purpose, due to its resistance to lateral movement through the water and because one hand only was available, the other being occupied in moving the boat along the tape. The figures being necessarily small, it was difficult from a standing position to read the rod at the water surface. We found it impossible for the rodman to tell, from his position in the boat, when the rod was plumb. In order to make any time at all with a rod, it had to be drawn nearly out of the water while moving laterally, and then thrown down with considerable force to overcome buoyancy and the lateral forces of the wind or the current.

There is found in the bottom of all dredge ditches in silt or clay soil ½ to 2 ft. of thin mud. It requires very little pressure on a thin rod to cause it to penetrate this slush, and the force used in throwing the rod down is usually sufficient to cause it to sink through the semi-fluid mud. While this gives the true value of the depth actually reached by the dipper, it gives a more or less false value with respect to the actual amount of material removed. The use of a spread footing or shoe to

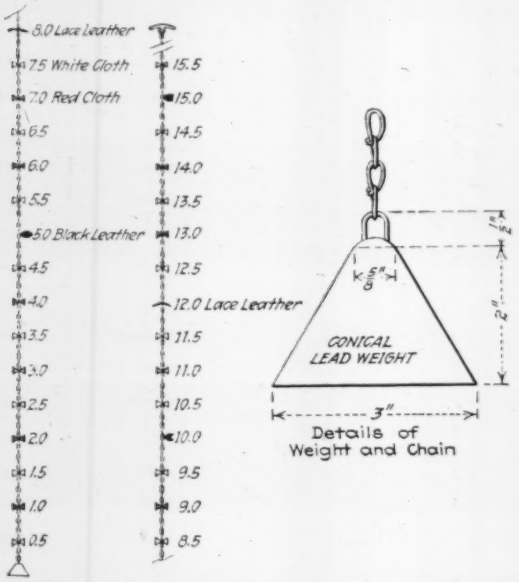


FIG. 7. SOUNDING LINE USED ON DRAINAGE DITCHES

increase the bearing area of the rod was not practical, as it in no way helped the resistance to lateral movement, made the rod harder to handle vertically, and slowed up the work. It is easy to see that the errors incident to the use of a rod are all in the contractor's favor, and a few of them made verbal complaint when its use was discontinued.

Three Kinds of Chain Tried

When looking for a means of overcoming these difficulties, a lead line, such as is used on the river boats, at once suggested itself. We required greater accuracy than that required on a river boat, and a chain promised to give better results than a rope, both as to constant length and ease of marking. Three kinds of chain were tried before one was found that gave satisfaction. First, brass sash-chain was tried, the links of which were stamped from sheet brass and looped through each other. This was far from satisfactory. When the weight caught on a root or other projection under water, and the 18-ft. chain was subjected to considerable tension, it would permanently increase in length 0.3 or 0.4 ft., and when accidentally stepped on while in the boat the links would be flattened and the chain would lose much of its flexibility. A steel chain was then tried, the links of which were made up of flat steel wire. This chain stood the accidental strains put upon it without material increase in length, but tangled and kinked to so great an extent that it had to be abandoned. Finally, a chain having locked links made of No. 18 round steel wire was tried and answered all the requirements. (See Fig. 7 for a sketch of the system of marking and details of the chain and weight.) The marking of the chain proved a simple problem, as 0.5-ft. intervals made it possible to read to within 0.1 ft., which was a greater refinement than is justified with dipper-dredge work.

A leather tab was sewed at each 5-ft. mark. The intermediate footmarks, with the exception of those at 8 and 12 ft., were indicated with small pieces of red cloth tied through the links nearest the correct distance. Pieces of lace leather were tied at the 8- and 12-ft. marks, as depths 1 ft. either side of these marks prevailed. Small strips of white cloth were used to indicate the 0.5-ft. marks.

The weight was made of lead or cheap babbitt metal cast in the form of a cone, with a wire staple projecting from the top. Two pounds proved ample to weight the line on a greater part of the work. Where more weight was found necessary an iron nut or some washers placed over the weight furnished the additional stability. With this weight and line, the measurements, or soundings, were those along a plumb line, except in swift water, and as the chain offered very little resistance to water it had only to be lifted a foot or so when moving to the next point.

With the chain taut, the weight used was not heavy enough to penetrate the slush, and therefore the results more nearly approximated the correct ones. Some of the contractors objected to this method, on the ground that on other work, which had been sounded with a pole, the slush was disregarded. In other instances, where the contractor had previously sounded the ditch with a pole and found it apparently to grade, and our measurements would show it above grade, the contractor had to be "shown" by checking the line and measurements.

Only Small Quantity of Work in Swift Water

On stretches of pilot cut connecting two reaches of finished ditch, which were short enough to act as contractions in the larger channel, the current was, at times, too swift for accurate work with the line, but this objection also applied to a rod, and as dams were placed across them except during a high water, the quantity of work that was done in really swift water was comparatively small.

The chain was checked up at least once a month, and the placing of the marks was corrected if the error was found to be sufficient to justify it.

After the stakes were set and other preliminary work was done, this method permitted us to cross-section 50 stations of the largest ditch in ten hours. These cross-sections averaged 30 soundings each, making possible a total of 1500 readings per day and representing 250,000 cu.yd. of excavation. There were only a few instances where there was enough work to require a full day of straight sounding.

While it is departing somewhat from the subject as indicated by the title, it may be of interest to some to mention another detail of the construction work, illustrating the difficulty encountered in doing work which in principle is the limit of simplicity. It was required to set slope stakes on each side of the ditch across a flag field one-half mile long. The ground was near enough a plane to permit the stakes being placed in a straight line. The obstacle consisted of 5 ft. of water and 1 ft. of soft mud. Ten-foot "stakes" were used, and the rodman worked in a boat. A foresight was set from a reference point by working in boats. The instrument tripod was made 10 ft. long by splicing poles on the legs with wire. The instrumentman lined the stakes in from a boat held in position behind the instrument by means of more poles. There were other cases where compass lines were run in this manner.

L. L. Hidinger is chief engineer of the Little River Drainage District.

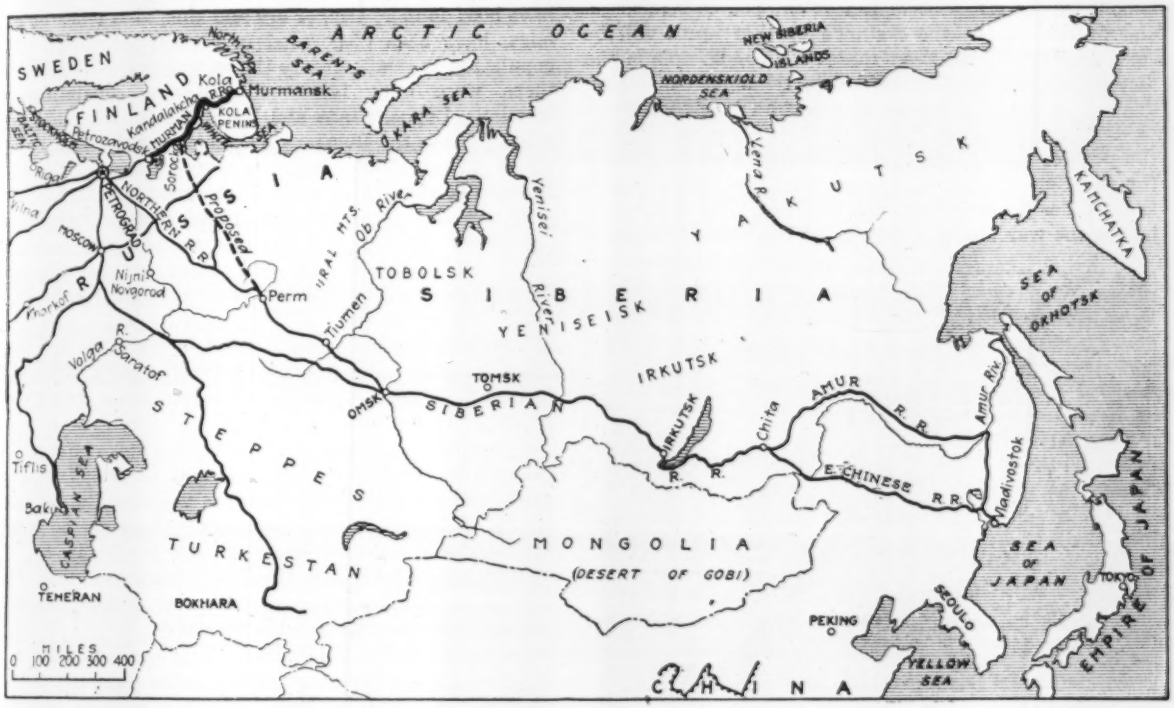
Murman Railroad: New Outlet to Sea in Russia

Ice-Free Port on the Gulf of Kola Is Reached by Connection From Northern Railroad—Freight From Siberia for Export Provided With Shorter Route

By V. Goriachkovsky
Vice President, Youroveta Home and Foreign Trade Company, Incorporated, New York City

VAST possibilities for development of Russia as soon as conditions become settled make a description of the railroad connecting the new port of Murmansk, situated on the Gulf of Kola which never freezes, although it is one of the most northerly ports in Russia, of special interest at this time. This road was built during the second year of the war as a result of the necessity for Russia to have a direct connection with the allies. All communication through the Black Sea was cut off when Turkey declared war and closed the Dardanelles. The Baltic Sea was closed by Germany. The only access left was through the north, by the White Sea and Archangel harbor, but the latter is closed every year for a period of five to seven months during the winter when drift ice clogs the White Sea outlet to the Arctic Ocean, and renders navigation impossible. This article outlines the general conditions and the details of the construction of the Murman R. R., 650 miles long, successfully completed in 18 months, beginning in the spring of 1915, with the author as chief engineer. While this article is based upon an informal address delivered at a meeting of the American Society of Civil Engineers in New York, additional descriptive matter has been introduced.

Starting from the port of Murmansk on the north, located on the Gulf of Kola, which, owing to the Gulf Stream coming from Central America around the Norwegian coast, is open to navigation all the year around and has natural facilities making it accessible to ocean-going steamers of the largest tonnage and deepest displacement, the Murman R.R. follows the Kola River valley, near Imandra Lake, up the Neva River valley, spans Kandalakcha Bay, touches the towns of Kem and Soroka, and reaches the town of Petrozavodsk. From this point to its connection with the Vologda-Petrograd R.R. at Zwanka, the railroad was formerly privately owned. The new road was projected in 1915 as a Government railroad to connect with the latter existing road, which was then bought by the Government. It was laid out by the late Czar Nicholas personally, who wanted the railroad constructed on old Russian territory and not through Finland, on the advice of his short-sighted experts and friends.



PRINCIPAL EXISTING RAILROADS IN RUSSIA AND PROPOSED CONNECTION WITH NEW MURMAN RAILROAD

The line of the Murman R.R. runs along the eastern part of the so-called Scandinavian Shield territory. This territory was profoundly affected by the glacial epoch; the powerful glaciers descending from the Scandinavian Finnish heights brought great destruction and deposited masses of glacial material in their wake. When the ice melted away, the numerous basins and hollows became filled with water, and gave origin to lakes, many of which have either entirely disappeared, or have been transformed into marshes and turf pits. The railway, therefore, was built partly through mountainous country of irregular hills of granite and partly through swamps divided by lines of mountain rocks, or along the steep slopes of rivers and lakes.

The climate, of course, was very severe, with long winters. The first snow falls on the Kola peninsula in August. The mean temperature in winter is 14° F. During the winter months the thermometer hovers around —23° F. There is no sunrise during two months, a period known as the "polar night." It is fairly warm in summer, with a mean temperature of about 51°, and the sun does not descend below the horizon at all; this is the season of the "midnight sun."

The port of Murmansk lies nearer to America than any other Russian harbor, and is nearer to Siberia than any other ice-free port in Europe. As soon as the new railroad from Soroka to Perm, noted on the map by the dotted line, is built, the freight from the Ural region and from western Siberia can be shipped to Archangel and Murmansk, as the distance by this route will be considerably shorter than that by Vologda. Thus the distance from Perm or Omsk to Archangel will be reduced by 282 miles, giving Archangel a tremendous advantage over Petrograd, as during the winter, when the port of Archangel is covered with ice, the freight for shipment abroad will be sent by Murmansk, which is 133 miles nearer Omsk than is Libau. The latter port before the war was the harbor for importing to Siberia

TYPICAL CUT THROUGH GRANITE OR DIORITE

all American goods, and for exporting a million tons of goods, mostly butter, from Siberia.

Siberia ships such products of animal husbandry as butter, cheese, meat, bacon, hogs, bristles, wool, etc. In the eastern direction American agricultural implements, dredging machinery for the mining industries, steam shovels and road-building machines, separators for milk, turbines, timber-sawing machines, chemicals, automobiles, cloths, cotton, etc., are transported.

In addition to the through freight, this proposed new connecting line would carry a tremendous quantity of local shipments. It is stated by Professor I. D. Simpson in the *London Geographical Journal* of June, 1918:

"I believe that this region will one day prove to be something infinitely more profitable to Russia than Alaska has proved to the United States."

As it was expected that the future trade through the new harbor would be large, the harbor of Alexandrovsk, which had been selected many years ago by Count S. Witte, was examined to see whether it was sufficiently adapted for the purpose. It was found that the bays were surrounded by high granite cliffs without sufficient space near the water for placing a big railroad terminal with the necessary tracks, yards, etc. For this reason Alexandrovsk had to be abandoned and another location sought. Finally, in the Kola inlet near the Semenovo Islands was discovered the location for the future harbor, which the author named Murmansk. This location was selected as the best harbor in the whole Kola Bay, which is here 1½ miles across and 32 ft. deep near the piers and 70 ft. deep in the middle.

Country, Inhabitants and Occupations

The country over which the railroad is located is unexplored. The difficulty in traveling prevented the making of geological surveys, although iron ore and silver lead ore are found in many places, and traces of gold have been found. Copper ore and zinc, also asbestos and mica, have been discovered in several locations. The population is small; before the railroad was constructed there were only 14,000 inhabitants, consisting of Russians, Lapps, Finns and Karelians, in the Kola peninsula. Here the Russians were never under the Tartar yoke, and therefore speak very pure Russian. The first Russian settlement at Kola is recorded as early as the year 1264. Agriculture and animal husbandry are undeveloped. Among the domestic animals are reindeer, for transportation of mail and passengers, but few cattle and horses. The chief occupation is fishing.

The lumber trade is of great importance, the country in northern Russia being covered by forests exceeding 325,000 square miles in extent. For the most part these forests have not been explored, except along the banks of rivers where rafting is possible. The best forests, with very thick growth, are near the southern part of the railroad in the Olonetz district, and further from the sea in the Kem district. There is very profitable hunting for wild birds and wild animals. There are no roads, the inhabitants do not know what a wagon is, and to communicate in summer they use rivers and numerous lakes, although traveling in canoes is difficult because many cataracts make portage necessary.

Surveying had to be begun in the winter of 1914-15 in order to prepare for construction in the summer, beginning in the month of May. There were very few villages along the proposed line, making it necessary to live in tents or sometimes to sleep in a sledge with the temperature far below zero. For the survey and construction of the railroad the whole line, 650 miles long, was divided into three administrative districts: First, from Petrograd to Soroka; second from Soroka to Kandalakcha, and third from Kandalakcha to Murmansk. At the head of each district was a special assistant engineer, who had had wide experience in railroad construction in rugged sections of Siberia; to these were subordinated the section superintendents, each of whom was in charge of about 50 miles of line.

There were no previous surveys available except one of the first district, which was made about 15 years before. The maps of that territory were by no means exact or detailed, having been drawn on a scale of 1 in. : 10 versts (6.63 miles); these maps were not based on measurements but were composed principally in accordance with data obtained from local forest administrations, from inhabitants or travelers. They could be used only for preliminary and approximate figuring, as they contained neither altitudes nor exact distances. In the second and third districts preliminary surveys had to be made in the winter in order to obtain necessary al-

titudes by the aid of barometers, while in laying out the first districts the previous survey could be used for data on altitudes and location of river beds.

The leader of each surveying party received detailed instructions regarding the layout of the proposed line, and also auxiliary tables to aid in the location of stations and passing sidings. It was required to survey a single-track line with a capacity of seven daily trains in each direction for the first year, but with a view to allowing 13 trains in laying out first-class sidings, and finally increasing the capacity to 23 daily trains in each direction after the second-class sidings are laid. The theoretical running time of the trains between two consecutive stations was calculated, and tables were prepared giving the speed of normal trains pulled by standard locomotives on various grades, curves and straight sections. By the aid of these tables it was easy to compute the required traveling time from one station to the following.

All the calculations of distances were based on tape measurements in the field,and all altitudes were determined by the aid of leveling instruments. When the running time of trains had been calculated according to the tables, a suitable level site was selected for the future station. From there the engineers started again in the direction of the line and continued their reconnoissance, while separate parties of engineers remained on the line already determined in order to prepare profiles of especially difficult sections and to locate the line on slopes so as to minimize the amount of earthwork. As the territory was entirely without population, the location of the stations was determined exclusively by the endeavor to apportion the distances between stations as nearly as possible in accordance with the required running time of trains.

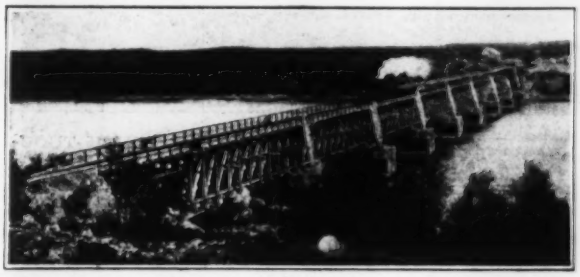
The specified conditions for the construction of the road were as follows: Minimum radius of curvature, 2100 ft., although in special cases 1050 ft. was used; 0.6% maximum grade from Soroka to Murmansk and 0.8% from Soroka to Petrozavodsk. In order to accelerate construction and reduce the amount of earthwork the road, however, was built on a 1.5% grade. The restoration of the originally planned 0.8% or 0.6% grade will require little reconstruction as the excess grades are nowhere of great length, and the track will remain in the same location.

Construction of Bridges

The bridges across all rivers and creeks are of wooden construction and designed to be easily replaced by permanent bridges later on. Therefore, at the larger rivers they were built on auxiliary lines, so that the future permanent steel bridges could be constructed on the main line alongside the wooden bridges without interrupting traffic. The small wooden bridges will be replaced later by stone culverts, and their construction was such as to permit the setting of the masonry supports without interfering with the movement of trains.

The bridges, 1112 in number, of timber construction, were designed with a view to reduce the amount of iron to a minimum and to use the simplest type. They were standardized as follows: Spans of 14 ft. or less, plain round logs; spans from 14 ft. to 35 ft., braced timbers; spans from 35 ft. to 70 ft., special trusses consisting of upper and lower chords connected by a system of diagonals and vertical web members. The trusses were as simple as possible; for example, the web members were not hewed to cylindrical shape, but butts and tops were joined alternately; all connections were made without notching or rabbetting the logs, using steel plates and screws. The bridges were tested by loading with two locomotives and a loaded train.

Foundations for the wooden bridges were usually of piles, except in stony ground where boxes, constructed of logs and filled with stones, were used. These boxes or cribs, in the case of the swifter rivers, were constructed



TEMPORARY BRIDGE ACROSS KEM RIVER—800 FEET LONG, 70-FOOT SPANS

with double walls and with a bottom for the inner compartments only. This was found quite effective in preventing washouts in the spring torrents, the stone contained between the two outer walls of the box dropping down to fill the place of material under the base, it being necessary only to fill up with stones the outside compartment of the box when the contents had settled.

Special Difficulties at Swamps

The swamps needed special examination, and had to be thoroughly explored. These swamps, covered by deep snows, never freeze. Their depths were determined by long poles, the shallow places being designated on the surface by yellow flags, while the deep places were indicated by red flags. Separate crews of workmen assigned to this work facilitated the final survey. The swamps consisted mostly of peat, which filled them to the bottom. These swamps covered more than 200 miles, or about 30% of the line. The laying of the line on this swampy ground required special and different methods of construction. Very often a temporary line, consisting of a number of longitudinal and traverse beams, had to be laid first, partly with the object of allowing the first train to go through and make it possible to fill in the swamps with sand and gravel.

Laying the track followed immediately after the construction of bridges, embankments and cuts, and had to be carried on through the autumn and winter. As the work was very urgent, track-laying continued throughout the 24 hours of the day. For making embankments and excavations 100,000 workmen and 15,000 horses were needed, 30 big steam shovels, 120 miles of light, narrow-gage railroad, 20 locomotives and about 2000 cars. The final work was completed during the summer of 1917, when embankments were raised and cuts were deepened, so that the grades became easier, sharp curves were reduced, and the greater part of the road-bed sufficiently ballasted. Sidings were laid out, and at the stations double, independent water-supplies were constructed, and preliminary wooden roundhouses and locomotive shops for small repairs, with offices and warehouses, etc., were completed. All the buildings were of

WAGON ROAD THROUGH SWAMP OVER WHICH THOUSANDS OF TONS OF MATERIALS WERE TRANSPORTED

wood, even the water towers, which were completely equipped with pumps and vertical boilers. Movable electric stations were placed in box cars, with all equipment necessary to furnish electric lights. In Murmansk a big electric station was constructed for the purpose of lighting up the harbor, terminal station, roundhouses, houses and barracks.

The last spike was driven Nov. 5, 1916. Of the whole of the 650 miles of the Murman railroad, 30% is above the polar circle, making it the most northern railroad in the world. As soon as the last rails were joined traffic started, although unfortunately the allies had not felt that the road would be open so soon and had sent to Vladivostok most of the munitions, 750,000 tons of which never reached the front. As a result, the Murman railroad was idle until January, when the first steamer arrived at Murmansk. From that time, in the most busy month the average number of cars loaded with war goods was 120 a day, about the same number as was being loaded and shipped from Vladivostok, which is eight times further from the front than Murmansk. All munitions arriving at Murmansk were successfully transported to the front.

Construction of Piers at Murmansk

Most of the ports in Russia are similar to those of the German type, with long wharves or quays following the shore line and with warehouses, parallel to the tracks, for storage. In the design and construction of the port of Murmansk, the American system of separate piers at right angles to the shore line was followed. These piers are of timber construction built on piles; the tracks on the piers were located so as to bring the cars alongside the steamships. Most of the incoming cargo had to be unloaded by the aid of deck cranes on the ships and then transferred to the port warehouses by trains. For unloading heavy units a traveling locomotive crane of 20-ton capacity was used; for freight exceeding 20 tons a floating crane of 35-ton capacity was employed.

There are no warehouses on the piers, as the latter are intended only for transfer of freight from steamships to cars, or vice versa. In 1917 several piers were completed which provided unloading facilities and mooring space for seven ocean-going steamships.

There were excavated about 15,000,000 cu. yd. of earth; more than 50% of this excavation was transported to embankments, an average distance of about 3000 ft. Excavations in granite were blasted out by dynamite, and amounted to about 2,000,000 cubic yards.

Workers were gathered from all parts of Russia, Siberia and the Caucasus, and included Russians, Poles, Tartars, Armenians, Kirghes, Kalmuks and prisoners of of war—Hungarians, Germans, Turks, Austrians—and even Chinese, altogether more than 100,000 men. Many troubles arose because of the differences in customs, religions and races. Slavonic prisoners always fought with the Germans and had to be separated from them. The Tartars refused to use meat, as the cattle were not slaughtered according to their religious custom, and they carried their prejudice even to the point of refusing to use the meat brought in the same wagon as that used by the Christians. The Mohammedans in Murmansk refused to eat food, recently arrived from America, when, according to their religious rules they must fast until sunset, and as it was then summer, when the sun does not set in Murmansk, it was necessary to bring them to Kandalakcha where they saw the sun set behind the mountains, and thus their lives were saved.

There are great possibilities for engineering in Russia, which has only 43,300 miles of railways, while in America there are about 260,000 miles. Many towns are without public utilities and municipal improvements such as water-supplies, sewerage systems, electric-light and power stations, etc. Russia has immense quantities of various kinds of raw materials awaiting the reconstruction of her industries.

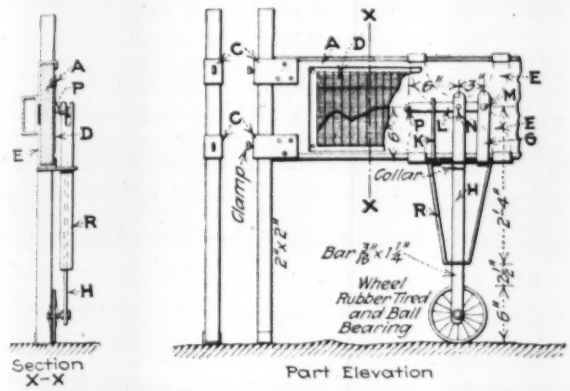
Contour of Pavement Traced to Exaggerated Scale

Device Measures Irregularities of Surface and Plots Profile With the Ordinates Multiplied by Three

MEASURING the irregularities in the surface of pavements and plotting them to an exaggerated scale on paper is performed by the instrument developed by F. A. Hermans, engineer of grade crossings, New York State Highway Department. While the method is somewhat similar to that described in *Engineering News-Record* of Oct. 17, 1918, p. 708, the exaggeration of the variations is said to be distinctly new. This feature should make it easier to study the results of a series of measurements where differences are small.

Referring to the diagram of the apparatus showing the details, A is a dressed plank of any desired length having two clamps, C, at each end. Through these clamps two square rods pass, which support the plank in a horizontal position. D is a suitably ruled piece of paper which is tacked to the plank. L is a lever pencil arm which is pivoted to the support at M and has a pencil point at P. A frame E buckles around the plank top and bottom and holds the support for the pencil arm and the guide for the vertical arm H. As the vertical bar attached to the wheel moves up and down, due to the irregularity of the surface, these irregularities are traced on the paper, three times their actual size. This results from the pencil arm being divided between the pencil and the fulcrum as 3 is to 6, by the point of connection with the vertical arm H.

When it is desired to map the surface of a pavement, the apparatus is set up at the proper elevation, and the



PIVOTED PENCIL ARM WITH UNEQUAL LEVERAGE EXAGGERATES VERTICAL VARIATIONS OF SURFACE

paper is tacked on at any desired height with reference to the pencil point at the point of starting. The frame E is then slid from one end of the plank to the other, the pencil marking out the profile. It is believed that a small knob would be better than the large 6-in. wheel, as it would register more truly the undulations of the pavement.

By setting up the device in connection with a bench mark, and placing the zero line of the paper horizontal and at the same elevation each time, seasonal variations may be measured and studied.

It is also asserted that the instrument is useful for studying variations caused by the shoving of asphalt surfaces due to traffic, the spreading of road crusts, and the amount of wear in a road under various concentrations of traffic.

Mileage of Main State Highways

State highways in the United States which come under the classification of main highways total about 203,523 miles, according to statistics just compiled by the American Automobile Association. Forty-four states have established definite systems of trunk highways, either by legislative action or action by state and local officials. It is pointed out that if the Federal Government takes over a system of from 50,000 to 75,000 miles it will cut the state systems by only from 20 to 25%, which would not affect materially the necessity for state highway departments.

The mileage of main state highways by states is given in the accompanying table that has been issued by the association:

State	Mileage	State	Mileage
Alabama	2,700	Nevada	1,400
Arizona	1,600	New Hampshire	1,390
Arkansas	2,000	New Jersey	3,147
California	3,000	New Mexico	6,250
Colorado	7,083	New York	12,287
Connecticut	950	North Carolina	3,356
Delaware	650	North Dakota	4,000
Florida	Not given	Ohio	9,880
Georgia	5,500	Oklahoma	10,700
Idaho	2,200	Oregon	4,805
Illinois	4,800	Pennsylvania	10,235
Indiana	2,000	Rhode Island	800
Iowa	6,000	South Carolina	2,550
Kansas	.....	South Dakota	6,000
Kentucky	8,000	Tennessee	Not given
Louisiana	5,000	Texas	12,620
Maine	1,353	Utah	3,660
Maryland	1,300	Vermont	4,300
Massachusetts	1,200	Virginia	3,740
Michigan	4,500	Washington	3,374
Minnesota	12,700	West Virginia	4,600
Mississippi	.....	Wisconsin	5,000
Missouri	7,500	Wyoming	3,100
Montana	2,400		
Nebraska	4,000	Total	203,523

Arizona Has New Water Code

By G. E. P. Smith
Professor of Irrigation Engineering, University of Arizona, Tucson, Ariz.

ARIZONA is to have a comprehensive water code, passed by the legislature just at the end of the session, although the opposition was so strong as nearly to defeat the bill. The main purposes of the code are the protection of vested and initiated rights to the use of water, protection of the interests of the public in the water-supplies, and encouragement for the highest possible development of such supplies.

Arizona, like 15 other Western states, will have one central office, where landowners and investors will be able to ascertain the extent of stream flow in any watershed and the existing rights to its use. The office of state water commissioner is created. Unusually great authority is centered in the commissioner, but provision is made for the right of appeal in all cases to the superior courts. The commissioner is appointed for a long term, six years, and it is hoped that the state water department will be and will remain absolutely divorced from politics for all time.

In the provision for the adjudication of all existing water rights, the code follows closely the Oregon method, which is based on the Wyoming law—but with certain fundamental improvements. After the accumulation of the data needed for the determination of water rights on a watershed, and after hearings of contests, the commissioner will prepare an order of determination, showing priority and extent of each water right. This order will be filed in the superior court, where additional hearings will be held before the order is affirmed by the court, but the order of the commissioner "shall be in full force and effect from the date of its entry in the records of his office."

Water Distribution Supervised

For supervision over the distribution of water, the state will be divided into water districts, each with a water superintendent and assistants. In general, the code permits the supervision to extend down to the individual water users, but on account of the opposition of certain valleys in which court decrees have already been obtained, all decreed rights are to be recognized *in toto*, and such rights will be incorporated into the orders of determination covering entire watersheds. The only objection to this is that in some cases excessive rates of flow have been decreed. The state water commissioner will divide the water of a river between the court water commissioners and such others as are entitled to its use.

The law provides for the approval of plans for dams and for inspection during construction, and for investigations of the water resources of the state. It contains the reciprocity clause of the Oregon code, providing for diversions in one state for use in another, and it contains the noncapitalization clause of the California law. It provides a special appropriation of money for the adjudication of the Gila River, exclusive of the Salt, and that will be the first work undertaken. The waters of the Gila are used in eight counties, and heretofore there has been no adequate legal machinery for determining relative rights in two or more counties.

The transference of water rights was the subject of much contention. As finally passed, the law permits

the transference of rights "if for any natural cause beyond the control of the owner it should at any time become impracticable to beneficially or economically use water for irrigation of any land to which water is appurtenant." In such case the right may be transferred "to other land under the same canal."

LETTERS TO THE EDITOR

Comment on Matters of Interest to Engineers and Contractors Will Be Welcome

Takes Exception to Classification of Railroad Engineers

Sir—The inclosed clipping [reproduced below] from the May issue of the *Monad*, published by the American Association of Engineers, should be a matter of concern to every technical engineer who regards himself as a professional man and looks forward to the day when an enlightened public shall accord him the recognition and esteem which his attainments warrant.

It is generally conceded, among engineers, that most of our present-day difficulties in securing recognition arise from our past failure to consider our own welfare, either as individuals or as a profession. Our sins have been of omission rather than of commission, and it is true that we have harmed only ourselves. It is just as true that we are beginning to see our mistake and are trying, to a certain extent, to go back and get a fresh start. A classification of railroad engineers such as this, emanating from such a source, sets a precedent which, if allowed to pass unchallenged, may prove a hindrance to our efforts. An exception to it, taken at this time, may rob it of much of its unintentionally harmful effect. As one engineer who hopes for a bright and useful future for his profession, I take that exception.

Cleveland, Ohio. ERNEST R. TAYLOR.

[The clipping referred to above follows.—EDITOR.]

JUST THE THING WE PROTEST

CLASSIFICATION OF ENGINEERS REQUIRED

(*Supplement No. 15 to Circular No. 2—Rates of Pay, Men With Technical Training.*)

It has been ruled by the Director, Division of Operation, that assistant civil engineers, draftsmen, or other men of technical training or experience who are not employed in the Maintenance of Way Department but are on the staff of the chief engineer, valuation engineer, or the general staff of the Mechanical Department, and are not classified as officials, should be classed as clerks and come within the application of either Supplement No. 7 (Article 6) or Supplement No. 8 (Article 2) to General Order No. 27.

Criticizes the Seelye Joint

Sir—In *Engineering News-Record*, of Mar. 20, 1919, p. 556, there is illustrated what is termed the Seelye joint. This is a method of joining wood timbers where under tension, as in roof trusses.

This joint is an adaptation of the old mortise bolt which is quite common in various kinds of wood framing but which has not been used in the particular manner described, for obvious reasons.

The Seelye joint, at the junction of the end rafter and the bottom chord, has no provision for vertical shear. The majority of roof trusses have a knee-brace near the end of the bottom chord, which brace exerts a vertical shear. There are also frequent loadings from the use of chain blocks or trolleys which exert vertical shear. To take up this shear, it is necessary to have the column cap, which Mr. Seelye illustrates as a part of the old-style truss. The cap should be placed under the Seelye truss and omitted in the old-style design. When the bottom chord of the truss projects beyond the end of the rafter, either an iron strap or a double timber dap will take up all the strain very nicely.

It is not economy to cut a vertical tie-rod in two pieces and make two mortise bolts, as Mr. Seelye illustrates in the vertical member of his truss.

No carpenter would consider making a clumsy tension joint in the bottom chord of a roof truss of the kind Mr. Seelye illustrates. If a tension joint is to be made it is customary to halve the two ends of the timbers for considerable distance back and introduce shear pins.

In general, the splicing of timbers for tension members is now nearly out of date. If a full-length timber cannot be obtained for the bottom chord of a roof truss it is preferable to use a built-up section. Five 1¾ x 8-in. plank, surfaced on one side to uniform thickness, will make an 8 x 8-in. built-up chord, of which the tension value anywhere will be 52,000 lb., at an assumed tension value of 1000 lb. per square inch.

Los Angeles, Calif. MAX J. WELCH.

[This letter has been submitted to Mr. Seelye and he has made the following reply.—EDITOR.]

Sir—In reply to Mr. Welch's criticisms, I would submit the following explanations of the joint:

The vertical shear is taken entirely by the end post.

Loads, such as shafting, may be taken on the lower chord by the use of lagscrews or small bolts, as indicated in the original cut.

The purpose of the bolster in the old joint is to counteract eccentricity due to the fact that the lower chord transmits its tension to the end post three lugs in its top surface only.

As to economy, a contractor has recently adopted this detail for a large number of lower chord splices in preference to fishplates and laminated chord alternates.

Why should lower chord splices become "out of date" when our timber supply is decreasing in the large sizes available? ELWYN E. SEELYE.

New York City.

Quick-Release Keelblock Not New

Sir—The article appearing on p. 881 of your issue of May 1, entitled "A New Quick-Release Keelblock," is an example of the partial truth in the old saying, "There is nothing new under the sun." I do not wish to be understood as suggesting that the idea illustrated is not quite original in so far as Eugene Lantz is concerned, but I take this opportunity of advising you that similar wedge-blocks were used as keelblocks in repairing steamers for the Union Steamship Co. of New Zealand at its Wellington slipway and its dry dock at Port Chalmers, N. Z., as far back as 1901, and by the British Admiralty at the Calliope dry dock at Auckland, N. Z., about the same time. These instances are of my own personal knowledge.

Hans Berents, consulting engineer, of Shanghai, China, tells me that he used similar wedge-blocks in

the erection of the bridges for the Anhui Ry. in China in 1910. Mr. Berents points out the necessity for taking care that the tapered keys do not project at their small ends beyond the face of the block, so as to eliminate the danger of accidentally knocking the keys loose.

F. H. FRANKLAND,
New York City. Consulting Engineer.

Engineers' Estimates in Relation to Careful Bidding

Sir—Road-building is developing so rapidly that it promises to become one of the biggest industries in the country. Contractors who have heretofore done other work may engage in road-building before long. This makes careful and businesslike bidding exceptionally important, and leads me to venture a word of caution with respect to engineers' estimates of cost.

In states where bids must not go over the engineer's estimate it is very important that estimates be made high enough to allow making a reasonable profit. Otherwise the work will be improperly done by unscrupulous contractors, or small bidders will secure the work and carry it along very slowly and inefficiently—ultimately without profit to themselves and without satisfaction to the engineer.

Should the engineer give out his estimate? I have reluctantly concluded that he should not. Some contractors will bid on the engineer's estimate, which may or may not be prepared carefully. A contractor who guides his bid by the estimate may then easily get into debt; and, on the other hand, the contractor who has carefully investigated the work, and who should really build the job, has no chance in the competition. Several states, notably Pennsylvania, do not publish the engineer's estimate. The practice should be made general.

Kansas City, Mo. CONSTRUCTION ENGINEER.

Nomographic Chart in Cofferdam Design

Sir—In *Engineering News-Record* of Apr. 10, 1919, p. 708, was a very interesting article by F. R. Sweeny on the design of single-wall cofferdams. The author derives formulas for the spacing of the wales and the thickness of the sheeting, and shows how to apply these formulas by the use of a diagram and a chart accompanying the article.

The construction of the author's Fig. 2 and the table on p. 710 must have been quite laborious and time-consuming. A splendid opportunity is there afforded to show the superiority of the straight-line or nomographic type of chart over the ordinary rectangular coördinate diagram.

Fig. 1 is a chart for solving the author's Eq. 3.

$$D_N = 0.314\,\frac{d}{s}\sqrt{\frac{kb}{wc}}\;(\sqrt{N^3} = \sqrt{(N-1)^3}$$

A similar chart can readily be designed for Eq. 6.

In this diagram, every variable is provided for and a complete solution of each formula is obtained from the diagram, no table of correction constants being neces-

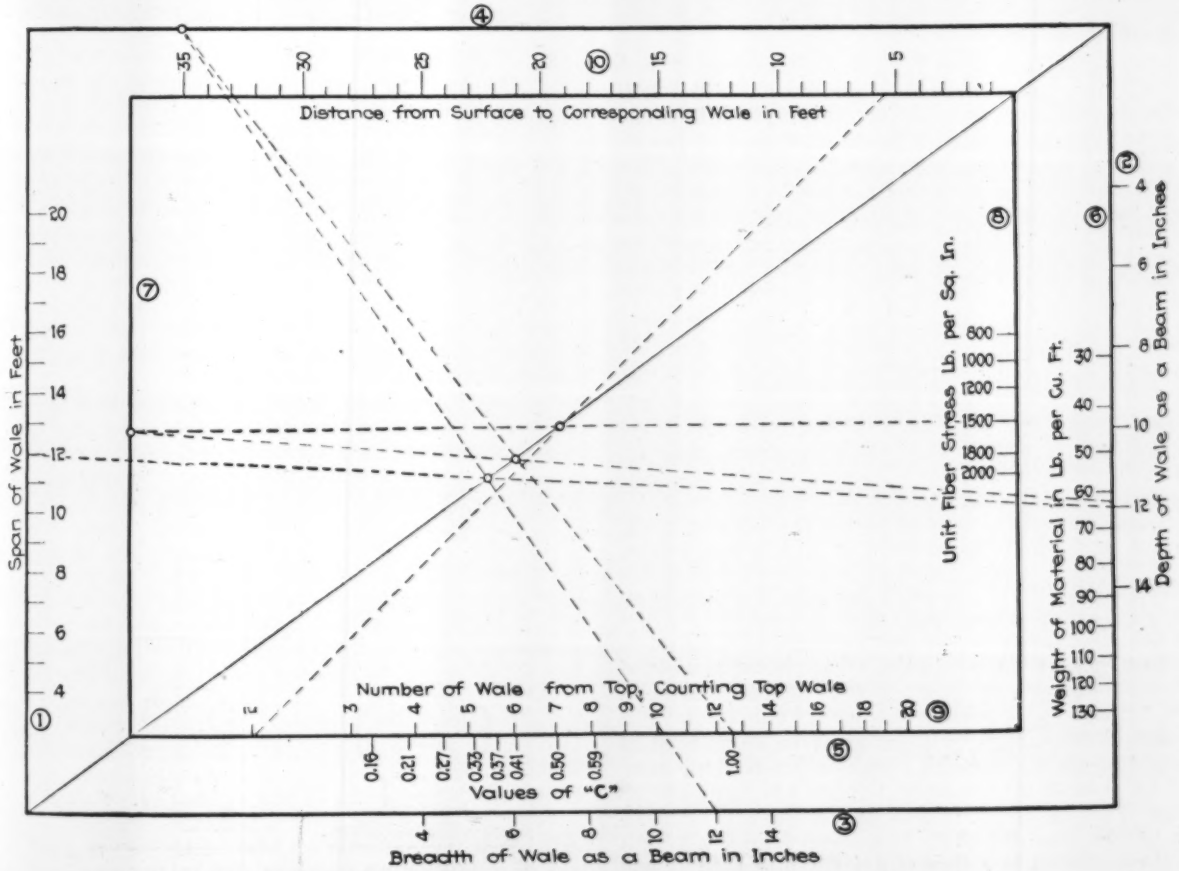

Distance from Surface to Corresponding Wale in Feet
Span of Wale in Feet
Unit Fiber Stress Lb. per Sq. In.
Weight of Material in Lb. per Cu. Ft.
Depth of Wale as a Beam in Inches
Number of Wale from Top, Counting Top Wale
Values of "C"
Breadth of Wale as a Beam in Inches

FIG. 1. NOMOGRAPHIC CHART DESIGNED FOR SOLUTION OF COFFERDAM SIZES

sary. All lines of the diagram are straight lines, which is a factor of great importance in all charts, both in construction and interpolation. The diagram can b constructed complete in less than two hours.

The method of using the diagram is as follows: Lay a straight-edge from the proper s on axis (1) to d on axis (2) and mark its intersection on the diagonal. Rotate the straight-edge about this last point and bring it to b on axis (3). Mark the intersection on axis (4). Rotate the straight-edge about this last point, and bring it on to c on axis (5), and then mark the intersection on the diagonal. Rotate about this point on the diagonal, bringing straight-edge on to w on axis (6) and then mark the intersection on axis (7). Hold this laast point and swing straight-edge about it to read k on axis (8), marking where the diagonal is crossed. Now by rotating the straight-edge about this intersection on the diagonal and bringing it to successive values of N on axis (9), the corresponding values of D and t may be read on axis (10). After a couple of solutions have been performed on the diagrams, the operation becomes almost automatic.

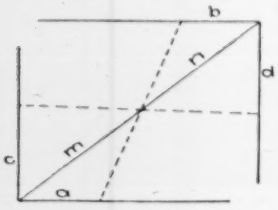


FIG. 2. BASIS OF CHART DESIGN

The chart is of the particular form of nomographs known as proportional charts and is based on similar triangles. In Fig. 2, $a/b = m/n$ and $m/n = c/d$, therefore $a/b = c/d$ where a, b, and c are certain functions laid off on the axes as shown to scales of S_1, S_2, and S_3 respectively. Then, if d is a fourth function laid off to scale S_4, where $S_1/S_2 = S_3/S_4$, the values of a, b, c, and d read on the axes will satisfy the equation $a/b = c/d$. This principle may be extended to more than four variables by an increase in the number of axes. Thus in Fig. 1 eight variables are handled.

The author's Eq. 3 may be written

$$3.18\,D = \frac{d\,k^{\frac{1}{2}}\,b^{\frac{1}{2}}\,P}{s\,w^{\frac{1}{2}}\,c^{\frac{1}{2}}}$$

where $P = (1\ N^3 - 1\ (N-1)^3)$. P is computed for different values of N and tabulated. Let $Q = \frac{d\ b^{\frac{1}{2}}}{s}$ and the equation becomes $3.18\ D/P = K^{\frac{1}{2}}Q/w^{\frac{1}{2}}\ c^{\frac{1}{2}}$. Then let $1/R = Qw^{\frac{1}{2}}\ c^{\frac{1}{2}}$, and the equation reduces to $3.18\ D/P = k^{\frac{1}{2}}/R$. Q and R are simply factors introduced to aid in the plotting. Each will have an axis but, since we are not interested in their numerical value, those axes need not be graduated.

Since $Q/b^{\frac{1}{2}} = d/s$, if $b^{\frac{1}{2}}$ is plotted to a scale of 1/0.6, d to $\frac{1}{3}$, and s to $\frac{1}{4}$, the scale of Q may be found from $\frac{\text{scale of } Q}{\frac{1}{0.6}} = \frac{\frac{1}{3}}{\frac{1}{4}}$, from which the scale of $Q = 1/0.45$.

Then, since $w^{\frac{1}{2}}/R = Q/c^{\frac{1}{2}}$, if $w^{\frac{1}{2}}$ is plotted to scale of $\frac{1}{2}$ and $c^{\frac{1}{2}}$ to $\frac{1}{0.2}\cdot\frac{1}{\text{scale of } R} = \frac{0.45}{\frac{1}{0.2}}$ from which scale of $R = \frac{1}{0.889}$.

P was plotted to a scale of 1/1 and 3.18 D to $\frac{1}{16}$ and from $\frac{\frac{1}{1}}{\frac{1}{16}} = \frac{1}{\text{scale of } k^{\frac{1}{2}}}$ the scale of $k^{\frac{1}{2}}$ was found to be 1/14.22.

Fig. 3 shows in diagrammatic form the layout for Eq. 3. This layout should always be made before construction of the actual diagram is begun. It is the key to the situation. The scales should be so chosen as to give a well balanced diagram and bring all the straight-edge intersections within the chart. The solutions for the following values of the variables is shown in Fig. 1 by dotted lines; $s = 12$ ft.; $d = 12$ in.; $b = 12$ in.; $c = 1.0$; $w = 62.5$; $k = 1500$ lb. per square inch; and second wale. The values of D and t are found to be $D = 5.5$ ft. and $t =$ slightly over two inches.

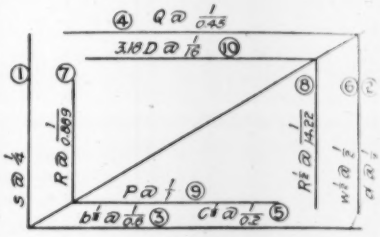


FIG. 3.

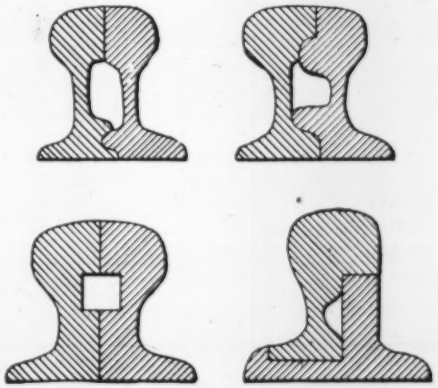
"Graphical and Mechanical Computation," by Professor Lipka, John Wiley & Sons, contains many valuable suggestions for the engineer in plotting charts of all kinds.

WARREN A. LYON,
Captain Corps of Engineers, United States Army.
Camp A. A. Humphreys, Virginia.

More on Old Compound Rail Sections

Sir—Compound rails of the type illustrated by the sections given on pp. 441 and 684 of *Engineering News-Record* of Feb. 27 and Apr. 3, 1919, were used to a considerable extent in the early days of railways. A paper by J. Elfreth Watkins on the development of rail and track, in the *Transactions* of the American Society of Civil Engineers, April, 1890, shows five such sections which were in use in New York State about 1855. These were of iron and weighed 65 to 75 lb. per yard. Three of them had the longitudinal joint in the middle of the head, while in the others the head was solid with half of its width supported on an L-shaped bar forming half of the web and flange. My impression is that similar sections were used on a number of old roads in the territory of the present Baltimore & Ohio Railroad.

Difficulty in maintaining splice joints with the old T-rails having pear-shaped heads is given as the reason


COMPOUND RAILS IN USE IN 1855

for the use of compound rails. They are said to have made good track at first, but in the absence of effective nut-locks it was difficult to hold the parts together rigidly, while in the divided head the wear was irregular, being especially severe on the inner section, thus causing rough track. An objection not mentioned in the paper is the tendency of frost to remain along the joint and thus cause the engine wheels to slip.

Mr. Watkins suggested the possibility that an improved compound rail made of steel and having secure bolted connections might be "the rail of the future," but, though there have been some modern designs, they have met with little consideration as competitors of the solid rail.

RAILWAY.

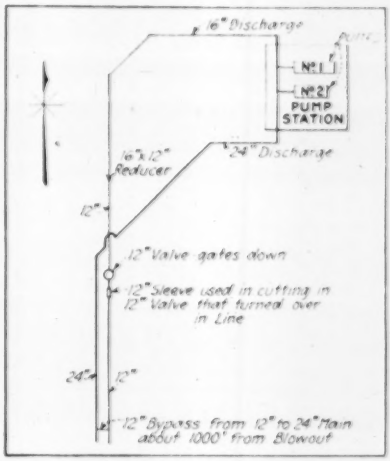
Chicago.

A Gate Valve That Turned in the Ground

Sir—The accompanying view shows the nearly horizontal position in which a 12-in. gate valve was found on digging down to it on account of a leak. The valve is on a force main near the water-works pumping station. The various connections are as shown in the sketch.

The valve was inadvertently left closed, and nothing was known of the fact until a blowout occurred. My explanation is that with the gate down and the nipple and sleeve on the discharge side of the valve, the pulsations from the pumps tended to push the valve off the end of the pipe and to close the space in the sleeve, left there when the cut was made. The continued strain finally caused a leak to start somewhere in the valve or sleeve joints, and it was several days before an attempt to repair the leak was made. Meanwhile, the leak became so bad we could put off attention no longer, and upon attempting to close the valve to shut off the water we could not reach the head nut. So we went back to the pumping station and shut off the water on the 16-in. line. We noticed that there was a great amount of movement in the piping and valve, so much so that with a sounding rod put down against the main one could distinctly feel the movement of the sleeve and valve with each stroke of the pump. The closing of the 16-in. valve just outside the pumping station stopped the major portion of the leakage and all of the vibration, as this left just the return line from the bypass connection shown in the sketch. The fact that the top of the valve rested against a large, heavy valve box, which in turn rested against a granite curbing, is all that kept the valve from turning further around than it did. The soil was light, fine sand, and when it became wet from the first small leak there was practically no lateral resistance to the movement of the valve until it carried the valve box over against the heavy curbstone. No attempt was made to right the valve. It was left in the position shown in the view, and a chamber was built around it so that a hand wheel could be put on the stem in place of a head nut.

VALVE TURNED TO A NEARLY HORIZONTAL POSITION



SKETCH SHOWING LOCATION OF GATE VALVE

In nearly 20 years' experience this is the first incident of the sort I have known. The pulsations of the pump are the only explanation of the turning of the valve that I can offer. The moral is: Never leave a valve closed on a main line if there is a chance that it will give way.

McKEAN MOFFITT,
Superintendent of Water and Sewers.

Wilmington, N. C.

Latin and Greek for Engineering Students

Sir—The suggestion of Dean Cooley in your issue of May 8, 1919, p. 930, that Latin and Greek be incorporated into the engineering curriculum, once more opens the discussion between the so-called cultural and industrial arts. It was long held that the study of Latin, Greek and the allied finer arts made for breadth and depth of the intellect, while the study of the sciences served a utilitarian purpose only. A falser distinction never was made. Cultural studies are those which promote not alone intellectual happiness and contentment but physical comforts also.

I do not deny that the study of Latin and Greek is an enjoyable one. I enjoyed both. But today the sole result of such cultivation is that, in working on mathematical equations, I can express myself fluently in the Greek alphabet, while my less gifted brethren must restrict themselves to English. I have often felt that I would have enjoyed myself as much and paved the way for future intellectual enjoyment had I spent the time on the study of natural history and the political sciences. I would be now in a better position to appreciate what is taking place and what has taken place in the world.

It is time to stop decrying the engineer as a man inherently without culture. It is not true. If the engineer cannot find time to become a *dilettante* in the fine arts, it is because he is too poorly paid; not because he lacks the cultural training. Herbert Spencer pointed out long ago the cultural effects of the pursuit of the scientific studies and the illusory effects of the cultivation of the dead languages. It is not necessary to repeat his unanswerable arguments.

New York City. G. PAASWELL.

HINTS FOR THE CONTRACTOR

DETAILS WHICH SAVE TIME AND LABOR ON CONSTRUCTION WORK

Road-Construction Camp Rationing When Convict Labor Is Used

CONTRACTORS and others using convict labor for road and bridge work should give special attention to the proper feeding of the men in the construction camps, according to the biennial report of the State Highway Department of Arizona. It has been found that failure to supply satisfactory food will cause trouble more quickly than any other single item of complaint. It is believed that this will also be found to be the case in free-labor camps.

On the work of the Arizona Highway Department the cooks and assistants were selected from among the prisoners. The rations were varied, and every effort was made to have them prepared and served in an attractive manner. In the desert regions it is necessary at times to use canned goods and dried fruits, but in general it is the aim to supply fresh fruits and vegetables in preference to all forms of canned goods. The accompanying table shows the kind and amount of food allotted to each convict during a period of one month at the Clifton camp, Arizona, having from 90 to 100 men:

RATIONS PER MAN PER MONTH

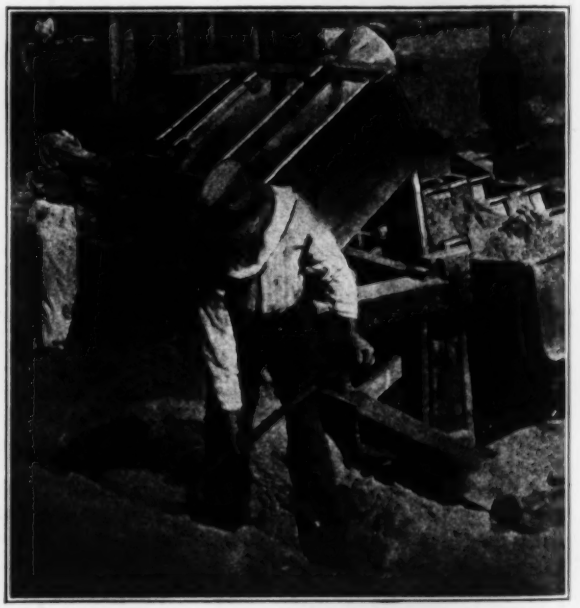
	Pounds		Pounds
Flour, wheat	12.0	Fresh beef, pork or mutton	23.5
Flour, milo maize	1.6	Flour, barley	2.0
Rolled oats	1.7	Cornmeal	22.0
Sugar	3.0	Macaroni	0.8
Prunes	1.5	Vermicelli	0.2
Canned peas	2.4	Dried apples	2.0
Dried peaches	0.1	Dried apricots	4.0
Canned tomatoes	4.4	Canned corn	6.0
Cottolene	4.0	Bacon	5.2
Beans	1.6	Ham	1.6
Onions	3.7	Lard	1.5
Velva syrup	5.0	Condensed milk	3.9
Coffee	2.6	Potatoes	17.0
Rice	1.7	Eggs	17.0
Cheese	1.0		

Properly Proportioned Batches Hauled to Mixer by Trucks

MOTOR trucks with specially arranged bodies were used to haul properly proportioned batches of concrete material to the mixer in building the Welsh-Mercer County Line road, in McDowell County, West Virginia. The stone and the sand were measured into specially constructed compartments on the trucks at the railroad siding, and hauled to and dumped directly into the concrete-mixer hopper, thus eliminating the extra handling which is necessary when materials are dumped upon the subgrade.

Ordinary motor trucks were used, the bodies being divided into four compartments by means of hinged trap-doors. The hinge edge of the door is formed of an ordinary gas pipe resting upon the top of the steel truck body and held in position by a strap-iron socket bolted to the frame. The lower edge of the door, which fits the bottom of the truck, is free except that it is attached to the front of the truck body by a cable to be released at the will of the truck driver. An illustration shows one of these trucks backed up at the mixer with one compartment dumped, and waiting for the hopper to drop and receive the next batch. The cables are so arranged that the batches can be dumped in succession.

Proportioning the concrete materials is accomplished at the railroad siding by the following method: The truck is run under the stone bin, and each compartment is filled with stone up to a mark which is painted upon the inside of the truck body. It then proceeds to the sandpile along the siding, where hinged measuring boxes are arranged on a small car running upon a narrow-gage track along the side of the sandpile, as shown. The sand boxes are placed the same distance apart center to center as the compartments in the trucks, and as soon as the trucks have reached their position at the side of the narrow-gage car the boxes which have been previously filled with sand are ended up by hand and dumped into the compartments. On



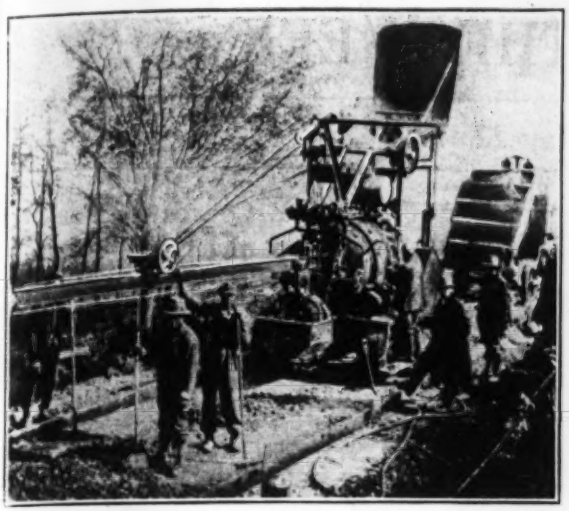
HINGED SAND-MEASURING BOXES ON CAR RUNNING BESIDE SAND PILE

Other Articles in This Issue of Interest to Contractors:

Sinking a Concrete Pumping Station in a River — Page 1013

Inspection of Drainage Ditch Cross-Sections After Contract Dredging — Page 1019

Engineers' Estimates in Relation to Careful Bidding (Letter) — Page 1029



SECTIONAL TRUCKS USED TO DELIVER PROPORTIONED BATCHES OF MATERIAL

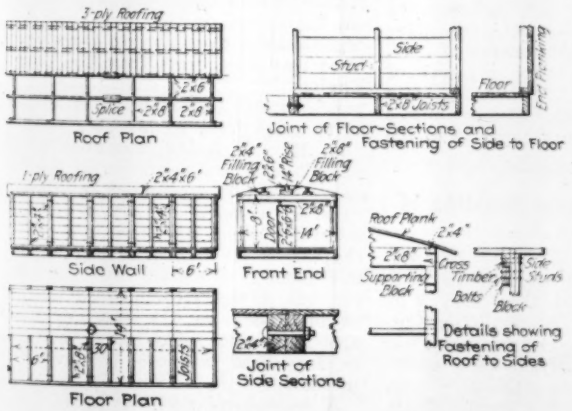
work having a sand as well as a stone elevator, this measuring could be done in the truck body.

The contractor for the work was the Harrison Engineering & Construction Corporation, Buffalo, N. Y.

Laborers Build Sectional Camp Houses

WOOD camp buildings built up in 6-ft. sections by laborers instead of carpenters as is usual, are shown in the accompanying drawings, the sections being put together with bolts through the abutting floor joists, side studs and roof beams. Each 6 x 14-ft. section is composed of floor joists, studs and roof-beams, with plank floor and sheathing. The roof is of the turtle-back type, composed of 16-ft. transverse planks bent over stringers blocked up on the roof-beams so as to give a rise of 14 in. At the eaves these planks are secured to sticks notched into the ends of the roof-beams. This roof planking is applied after the sections have been erected.

After erection the roof of the completed building is covered with three-ply roofing paper, fastened by nails and tin washers. Doors are provided in the ends, and a certain number of sections have windows framed into the sides. The sections are readily disconnected, packed for shipment and reassembled. Some of the buildings were serviceable after being moved six times. Most of the buildings are 30 or 36 ft. long, but shorter lengths are employed for such special structures as storehouses and camp hospitals.



SECTIONAL CONSTRUCTION FOR CAMP BUILDINGS

These camp houses were built in sections at the site by laborers under the direction of a boss carpenter, as no carpenters for building the houses in the usual way were available. In two weeks 60 houses were built by about 20 men; one group of six men building the sections, a second gang of six men erecting the sections, and a third gang of eight men putting on the roofs and the paper sheathing. This was the average distribution; at first all the men were engaged in building sections, and toward the end most of them were applying the paper. One carpenter-foreman supervised the three gangs. The laborers were paid 40c. per hour.

These buildings are used by the Walsh Construction Co. on its work of double-tracking the Indianapolis division of the Cleveland, Cincinnati, Chicago & St. Louis R.R. (See *Engineering News-Record* of Mar. 13, 1919, p. 524). The drawings from which the illustration was made were furnished by T. E. Earle, resident engineer for the railroad.

Compressed Air Line Connected to Water Mains for Fire Protection

A "SCISSORS" expansion joint in a wrought-iron compressed-air line, and a connection of the same air line to a cast-iron water main, are features adopted at the shipbuilding plant of the Beaumont Shipbuilding & Dry Dock Co., Beaumont, Tex. E. B. Van De Greyn, chief engineer, considers the scissors expansion joint more efficient in construction work than the ordinary telescoping expansion joint. It also has the advantage of being home-made, requiring mainly only nipples and elbows.

For fire protection, a connecting pipe runs from the cast-iron water main to the air line, the valve in which is, of course, ordinarily kept closed, and no water enters the air line. However, in case of fire the many small air lines which go to all parts of the work are at once made available as water lines by simply opening this valve. Boxes with such connections are distributed at frequent intervals throughout the yard.

J. W. Link is president and general manager of the Beaumont Shipbuilding & Dry Dock Company.

Cracked Water Jackets Repaired by Rust Joints or With Steel Cement

RUST joints, familiar to every contractor, can be used successfully to repair cracked water jackets on tractor engines, when the crack does not exceed $\frac{1}{32}$ in. in width. Drain off the water and close the drain cock. Seal the outside of the crack with putty or tallow. Using a solution of 1 lb. sal ammoniac to 1 gal. of water, fill the water jacket high enough to submerge the crack, and let stand 30 minutes. Then drain the water and run the engine for a few minutes to warm the jacket. Refill the jacket with the solution, let stand, drain and reheat. Repeat this operation three or four times, and a joint will be formed which will not leak. Wider cracks can be closed with steel cement applied according to the directions printed on the containers. These recipes are vouched for by the International Harvester Companies.

NEWS OF THE WEEK

New York, May 22, 1919

Civil Engineers' Society Plans for Convention at Minneapolis

At the American Society of Civil Engineers' forty-ninth convention, at Minneapolis-St. Paul June 17-20, the president, F. S. Curtis, will deliver the annual address at the opening meeting, at which Howard N. Winchell, president of the American Institute of Mining and Metallurgical Engineers, will also deliver an address on the "Mines of Minnesota," and F. C. Shenehon will speak on "Engineering Activities of the Twin Cities." The second day will be occupied by an automobile trip to various points of interest, and the party will be entertained by the Engineers' Society of St. Paul. The third day will be devoted to two all-day excursions, either one by trolley to Lake Minnetonka, or one by automobile (about 50 miles) to the Taylors' Falls plant, by invitation of the Northern States Power Company.

For the afternoon of June 20 an excursion to Duluth and the Missabe range iron mines is scheduled. On arrival at Duluth the party will be the guests of the Duluth Association of Members of the American Society of Civil Engineers and the Duluth Engineers' Club on an evening trip by steamer on the Duluth-Superior harbor. On Saturday morning a special train will be taken to the mines at Hibbing and, under the auspices of the Engineers' Club of Northern Minnesota, the party will then proceed by automobile 30 miles along the iron range to see the development of the Mesaba open pit mines at Eveleth. From there the party will proceed to the ore-shipping port of Two Harbors, where the ore docks will be inspected.

More Units of 23rd Engineers Scheduled for Early Return

The War Department has announced that three additional companies of the 23rd Engineers (highway engineers) have been placed on the priority list to be returned to the United States from France. The three companies are G, H and I. The Washington representative of *Engineering News-Record* reports that it is expected that additional companies of the 23rd will be ordered home from day to day.

Shipyards Authorized To Take Foreign Orders

Orders issued by President Wilson May 13 allow American shipyards to build ships for foreign account in so far as the work will not interfere with the building program for American registry. It is understood that all such foreign contracts will be placed under the supervision of the Shipping Board.

Employment Bureaus

Engineering Societies' Employment Bureau, 29 W. 39th St., New York City.

American Association of Engineers, 29 S. La Salle St., Chicago. Service to members only, but Army or Navy Engineers in uniform who are eligible to certified membership may join without payment of entrance fees or dues while in uniform and for six months after discharge.

Engineers' Service Bureau, 57 Post St., San Francisco. Only applications by mail or wire will be considered.

Professional and Special Section, United States Employment Service, 469 Fifth Ave., New York City.

Reëmployment Committee of New York City for Soldiers, Sailors and Marines, 233 Broadway, New York City.

Committee Appointed To Coöperate With Bureau of Public Roads

Appointment of a committee of state highway officials to coöperate with the Federal Bureau of Public Roads in carrying out the provisions of the Federal-aid road act and its amendments has been announced through the Department of Agriculture. A. R. Hirst, state highway engineer of Wisconsin, and president of the American Association of State Highway Officials, made the appointments, as follows: George P. Coleman, state highway commissioner of Virginia; S. E. Bradt, state superintendent of highways of Illinois; Charles J. Bennett, state highway commissioner of Connecticut; W. S. Keller, state highway engineer of Alabama, and Ira R. Browning, state road engineer of Utah. The committee will act in an advisory capacity to the bureau.

Fast Work Done in Building of 8800-Ton Ship

Built in 27 working days, the 8800-ton steamship "City of Eureka" was launched at Portland, Ore., May 8 by the Columbia River Shipbuilding Corporation. In building the ship work was carried on continuously, in three shifts. The performance established a new shipyard record for the Pacific Coast.

A. A. E. Convention Features Pay and Employment

Society Inter-Relations Considered, and Proposed Laws Affecting Engineers To Be Published

Salary schedules, employment problems and opportunities, proper compensation, and society inter-relations were the main features discussed at the annual convention of the American Association of Engineers May 12-13 in Chicago. Ninety delegates from 13 of the chapters and three clubs were present, although the attendance was 186 at the largest session.

Changes made in the constitution are as follows: A national practice committee is authorized, to report on questions of ethical policy and conduct; a grade of candidate junior is added; chapters are to recommend grading of candidates; junior members may now vote but not hold office; the latest past-president is to be a director; the board is authorized to make mutual agreements with other societies. (This is in confirmation of the affiliation plan carried out with the Cleveland Engineering Society.) The warmest discussion of the convention was over the proposal to fix the entrance fees at $5 or $10. The present by-law was retained; entrance fees, therefore, will continue to increase automatically by $2 for each 500 members above 1000, the count to be made in December and fixed for a year. Apprehension that the fees would be so high as to keep out younger members gave way to the idea of the increased service that could be rendered through the larger income.

Following an explanation of the similarity in work of the Engineering Institute of Canada with that of the association, by Fraser S. Keith, secretary of the former body, it was voted to leave the Canadian field to the institute and to coöperate fully with it. An indication of the desire of other organizations to enter into some agreement was a telegram from the Oregon Engineering Society asking for a proposal either to enter as a chapter or to make joint membership possible.

A. M. Van Auken, chairman of the committee on compensation of the Chicago Chapter, presented a comprehensive 19-page report, containing schedules, which had been made to the chapter on May 3. (See page 1005 of this issue.) Adoption was not asked for, but it was recommended that the national body use the data and schedules in a nation-wide study and seek to formulate a more comprehensive schedule.

A recommendation was adopted pro-

viding that abstracts of all laws applying to engineers and surveyors, which degrade and hurtfully affect the engineer, should be collected, published along with suggestions for better laws in the interest of the public and the good of the profession, and should receive the widest publicity. The St. Louis Chapter presented a schedule for the municipal engineers of that city, which was indorsed.

H. G. D. Nutting, in his paper on "Ways and Means of Obtaining Proper Compensation," indicated five ways which may be used to help the man who cannot develop sufficient initiative along selling lines. His suggestions were: Increase the demand; limit the number by license; limit the number of technical graduates (questionable); union methods (questionable); limit the fake correspondence school courses; limit the fake employment agencies with alluring offers.

F. H. Myers, speaking on the employment department, indicated that 10% of the dues is now spent on this activity. From 300 to 350 members are on the list to receive the bulletin of positions open. Circular letters to employers get 5% returns. For the week ending May 10, twenty-one men were placed in positions averaging $150 per month, at a cost of $45. Had these men gone to employment agencies the cost would have been $1890.

The next annual convention will be held in St. Louis. The results of the letter ballot for officers are as follows: President, F. H. Newell; vice-presidents, W. W. DeBerard and F. A. Evans; new directors, W. W. K. Sparrow, P. E. Harroun, R. Burnham, F. D. Richards, A. A. Matthews and E. F. Collins.

New York Governor Vetoes Water-Power Commission

Governor Smith of New York has vetoed the Sage Water-Power Commission bill which appropriated $100,000 to ascertain the cost of development, transformation and distribution of water-powers and urge upon the Federal Government the state's right of full control of boundary waters. Apparently the Governor did not think it desirable to spend more money in investigatory work and is in favor of some definite legislation which will permit immediate state water-power development.

State Purchase of Interstate Toll Bridges

A law approved by Governor Sproul of Pennsylvania, May 15, provides means for coöperation of the state with New Jersey in purchasing toll bridges over the Delaware River. The Board of Public Grounds and Buildings is to act for Pennsylvania in conjunction with a similar body designated by New Jersey. Purchase may be by agreement or under condemnation, but in fixing the fair value of the bridge and its approaches the commission must take into consideration the value of the franchise.

New President of American Association of Engineers

Dr. F. H. Newell, head of the department of civil engineering, College of Engineering, University of Illinois, was elected president of the American Association of Engineers at the annual meeting in Chicago last week. He has had an active part in reform movements in the engineering profession in the past few years, and has served as president of the Committee on Engineering Coöperation from its organization in Buffalo in 1915 to the present time. He was one of the founders of the Washington Engineering Society and served as its president.

Elected President of American Association of Engineers

F. H. NEWELL

Dr. Newell served as the first chief engineer of the United States Reclamation Service from 1902 to 1907, and from 1907 to 1914 he was director of the Service.

He is a member of the American Society of Civil Engineers, the American Society of Mechanical Engineers and the Western Society of Engineers, and is one of the original members of Engineering Council.

Preliminary Program of Concrete Institute Annual Meeting

At the annual meeting of the American Concrete Institute, to be held at the Hotel Traymore in Atlantic City, June 27-28, special attention is to be paid to the subject of concrete ships and of the developments which have arisen in their design and construction. Thus, there are two papers of particular interest to general concrete construction: "The Effect of Vibration During Placing on the Strength of Concrete," by Prof. D. A. Abrams, and "An Investigation Into the Economic Possibilities of Light-Weight Aggregate in Building Construction," by A. W. Stephens. There will be, besides, four papers on concrete ships proper: "Construction of Concrete Barges," by S. C. Hollister; "Layout and Equipment of the Government's Concrete Shipyards," by A. L. Bush; "Problems in the Design of Concrete Ships," by J. Glaettli, Jr., and "Problems in the Construction of Concrete Ships," by R. J. Wig. Special tests made in the investigation of concrete ships are to be treated in a paper entitled "Results of Investigation on Shear, Impact, and Bond Made for Concrete-Ship Studies," by W. A. Slater, and the development of the new strain measurer to determine the stresses in ships is taken up in a paper by F. R. McMillan entitled, "The Strainagraph and Its Application to Concrete Ships." Other important papers are: "Fire Tests of Concrete Columns," by W. A. Hull; "Temperature Cracks in Chimneys," by J. G. Mingle; "Concrete Work on the Brooklyn Army Base," by A. C. Tozzer; three papers on fuel oil tanks, by H. B. Andrews, H. B. Walton, and J. C. Pearson and G. A. Smith, and "Concrete Railroad Tracks," by A. C. Irwin. On June 27, at 8 p.m., a joint session will be held with the American Society for Testing Materials.

Mining Engineers to Hold Fall Meeting in Chicago

The fall meeting of the American Institute of Mining and Metallurgical Engineers will be held in Chicago Sept. 22-26, according to present arrangements. It is planned to make the meeting of considerable importance to the industry, and subjects of vital concern to iron and steel interests will be discussed. In addition to technical papers, a program of excursions to various points in the Chicago district will be arranged, including trips to the steel mills at Gary, oil refineries at Whiting, and to the La Salle district, where there are cement, coal and zinc industries.

New York Removes Motor Truck From Personal Tax Class

Through a provision in a revenue bill just signed by the Governor of New York, motor trucks are removed from the personal-property classification and are placed upon the same basis in this respect as the passenger vehicle. The only revenue levy that can now be collected from the commercial truck is the regular license fee.

No change was made in the license fee which has held for the past two years. This provides that a truck of one-ton gross weight or under shall be taxed $10 per year, and that $5 shall be added for each extra ton of gross weight. Thus the license fee for a five-ton truck whose gross weight would be about 2000 lb. would be around $55. The bill provides that this license fee shall cover all taxes whatsoever; thus cities and other Governmental units would be prohibited from levying taxes or requiring special licenses. Provisions have also been made for increasing the license fees on passenger vehicles, which means a tax up to $60 for the larger and higher-priced cars

Annual Meeting of Highway Traffic Association

Discusses Regulation of Motor Express and Traffic Control on Feeder Roads—Officers Elected

The organization and the development of highway transport, as well as the proper construction and control of the highways made necessary by this development, were the subjects of discussion at the annual meeting of the National Highway Traffic Association held at the Automobile Club of America, in New York City, May 14. The program, announced in *Engineering News-Record* of May 8, 1919, p. 938, was followed very closely. The subjects which brought out the most discussion were regulation of the motor express service and the control of traffic on feeder roads.

During the afternoon session practically every speaker touched upon the subject of the desirability of enfranchising motor express companies. It was stated that the principal reasons why motor express companies are failing are (1) Ignorance as to the cost of operation, and (2) inability to raise prices on account of cut-throat competition even if costs are known. It was the general opinion that legislation should be passed to limit the number of companies operating over any one route. Some, however, felt that franchises should not be given to motor transportation companies, and they suggested a campaign of education as to the cost of operation.

In the evening session, after the presidential address by Arthur H. Blanchard in which he defined the subjects to be followed in the study of "Highway Transport Engineering," and addresses on "The Townsend Highway Bill," by H. G. Shirley, secretary, Federal Highway Council, and "Highway Requirements," by W. G. Thompson, state highway engineer of New Jersey, a discussion of the control and construction of feeder roads was opened by E. J. Mehren, editor of *Engineering News-Record*, followed by George H. Pride, president of the Heavy Haulage Co., of New York. This discussion showed a wide difference of opinion as to the feasibility and desirability of restricting heavy traffic on side roads. It was pointed out that a very large percentage of present highways will not stand up under motor-truck traffic such as is proposed, with an allowed maximum load of 28,000 lb. However, no solution of the problem of keeping trucks off the feeder roads was reached. The fact was brought out that even legislative regulations at present in force are constantly broken, and it seems almost impossible to make the regulations effective. At the close of the session an instructive educational film for the promotion of good-roads sentiment was shown by the Universal Film Manufacturing Co.

The following officers were elected for the ensuing year: President, Prof. Arthur H. Blanchard; vice-presidents, David Beecroft and John T. Stanton; secretary, Elmer Thompson; treasurer, George H. Pride. The following directors were elected: Gen. T. Coleman du Pont, of Delaware; William P. Eno, of the District of Columbia; William P. Beatty, of Illinois; Charles Henry Davis, of Massachusetts; Walter R. Addicks, of New York; R. J. Corbitt, of North Carolina, and Philip A. Koehring, of Wisconsin.

Highway Bond Issue Vetoed by New York State Governor

Governor Smith of New York has vetoed the proposed state highway bond issue for $20,000,000. The funds from this bond issue were to be used largely in meeting the allotment of Federal-aid moneys to the state. He approved an appropriation of $25,000 for the employment of prisoners on state and county highways.

The ground given by the Governor for disapproving of the bond issue was that the bill was so framed that the manner in which the money is to be used would be determined by the legislature. He stated that in the past money so distributed had been treated as political patronage, and that highways were designated, not with the idea of serving the greatest number of people, but with the idea of benefiting the men with the most political influence. While this money was to have been used in combination with Federal aid, it is hoped that some other means may be found to supply the necessary funds, so that the work will not be delayed.

California to Vote on Highway Bond Issue for $40,000,000

A special election has been ordered by Governor Stephens, of California, for the purpose of submitting an amendment to the constitution providing for the issuance of $40,000,000 in highway bonds. This bond issue, which is in addition to several made in recent years, is for the purpose of making extensions to the state highway system.

Good-Roads Sentiment Strong in California

That good-roads sentiment is strong in California is evidenced by the vote upon a bond issue for $4,800,000 in Fresno County. Although this bond issue is larger than that voted by some states, it was carried by a majority of 7 to 1. Seven precincts voted unanimously for the bonds. It is felt that this is an indication of the vote which will be recorded in favor of the forthcoming state bond issue for $40,000,000.

Plan $5,000,000 Water Bond Issue in Tulsa

At a meeting of the Allied Civic Committee in Tulsa, Okla., May 9, which was called by W. C. Steger, chairman, final plans for holding a city election for the purpose of voting $5,000,000 in bonds for building a new water-supply system from Spavinaw Creek to Tulsa were formulated.

Cemcnt Companies Combine for Foreign Trade

Ten Manufacturers, Taking Advantage of Webb Act, Organize Cement Export Company

Portland cement manufacturers have just formed a company for foreign sales only, under the provisions of the Webb act. Ten companies have already joined the organization, which is known as the Cement Export Co. and has offices in New York City, and invitations to participate in the new organization have been extended to all Eastern cement manufacturers.

The following were elected directors of the company: Emil Loeb, Coplay Cement Manufacturing Co.; J. Brobston, Dexter Portland Cement Co.; J. A. Horner, Nazareth Cement Co.; L. C. Morton, Phoenix Cement Co.; George F. Bayle, Glens Falls Portland Cement Co.; J. W. Fuller, Allentown Portland Cement Co.; Frank H. Smith, Lawrence Cement Co.; Charles F. Conn, Giant Portland Cement Co.; Morris Kind, Hercules Cement Corporation, and F. W. Kelley, Helderberg Cement Company.

It is announced that arrangements are under negotiation with the Bureau of Standards to test all cement delivered by the export company and to certify that the cement fulfills all the requirements of the standard specifications of the American Society for Testing Materials.

As portland cement for domestic shipments is almost entirely delivered in paper or cotton sacks, and as most export shipments are called for in wooden barrels, the matter of cooperage is of great importance. Tentative plans have been outlined for the erection of a barrel-manufacturing plant at tidewater, with a large storage warehouse equipped with barrel-packing machinery in connection therewith. By having a large stock of cement in storage at tidewater at all times, the company, it is believed, will be able to take better advantage of the present somewhat limited shipping facilities to South American countries. While the Cement Export Co. expects that its activities will largely be confined to Latin-American countries, it will be in a position to supply cement to European countries if conditions make this desirable.

Feeder Cables a Factor in Bridge Fire

A small fire that broke out on an emergency footwalk on the Williamsburg Bridge over the East River, New York, May 18, led to a heavy short-circuit of electric feeder cables strung directly under the walk. A short length of the walk and a considerable amount of cable were destroyed, and one steel track stringer was damaged enough to require replacement. Because of the part played by the feeder cables in this accident, Public Service Commissioner Nixon has undertaken to provide ducts or other inclosure for the cables.

Disintegrated Sewer Concrete Requires Repairs

Stretch of Sewer in a Chicago Industrial District Breaks Down Below Water Line

Disintegrated concrete appears over nearly one-eighth of the inside area of a 63-in. concrete sewer built in Chicago in 1908. Extended investigation of the faulty structure by one of the editors of *Engineering News-Record* disclosed the following remarkable conditions: In many places the disintegration reaches entirely through the shell. The concrete at these places is rotten; it can be dug away and picked apart with the fingers. When excavated and hoisted to the surface in the process of repairing the sewer few pieces of this spoiled concrete are as large as a man's fist, and much of the débris is as fragmentary as was the original gravel aggregate.

The faulty sewer is a portion of the eight-mile sewerage system of the Clearing Industrial District, located in the southwestern outskirts of Chicago. These sewers are not a part of the Chicago city system; they were built and are owned by the district. Of the total system, only Sec. 7, which is the sewer on 63rd St., exhibits disintegration. This section is 7924 ft. long and is a monolithic concrete sewer 63 in. in diameter, with an 8-in. and 12-in. shell. It was built in 1908; it was the last of all the sections, and it was built as a separate contract.

Portland-cement concrete was employed. The cement was given the usual tests by a reliable commercial testing laboratory and was passed by the laboratory as satisfactory. The sand and gravel were from pits which have furnished aggregate for many successful concrete structures, and both passed inspection. The proportions were 1 : 2½ : 5. All concrete was machine-mixed. A fairly dry mixture was employed. Construction methods followed ordinary good practice. The invert concrete was placed first, then forms were set up, and the remainder of the concrete was placed from the top. There were no longitudinal construction joints. The trench was in stiff clay, giving excellent backing for the structure.

Disintegration affected the whole length of the section. It is more severe in some stretches than in others, but there is no regularity in the alternation of the more and the less damaged stretches. The damage is confined to the bottom and to the sides below the horizontal diameter. It is mostly at the normal water line. Above this level on the sides there is an occasional bad spot. The roof is invariably hard and sound. Disintegration often extends through the shell. Where it exists it is complete; the concrete has no coherence or strength. The extent of the damage is indicated by the amount of repairs entailed in the 1300 ft. of sewer on which work has been completed. Repairs were necessary on 79% of the length and on 11.8% of the internal area. Indications are that these proportions will be less as the work proceeds toward the head of the section.

In this connection attention should be called to the disintegration of the concrete in one of the Chicago stockyards sewers, reported in *Engineering News* of Sept. 14, 1916, p. 486. In that case, however, the sewage was notoriously putrid, and the disintegration was practically entirely in the arch above the water level.

The sewage in the Clearing district is the waste of industrial plants, house sewage and storm water. Only the wastes from the Commercial Chemical Co. can be suspected. The disintegration is as prevalent in the sewer 600 ft. above the point where the chemical wastes enter as it is below this point, and is no greater near the entrance than it is at more distant points. Furthermore, the disintegration ceases where Sec. 7 joins Sec. 5, constructed at another time. All the system, it should be noted here, except Sec. 7, was built of puzzolan cement and at a previous date, and none of its length shows any disintegration. It is only the 2000 ft. of Sec. 7 which is not in perfect condition.

The damaged sewer is being thoroughly repaired by its owners. Samples of the disintegrated concrete are being submitted to a number of experts for analysis and tests. When these are completed the results will be available for whatever they may be worth.

Benjamin G. Lamme Recipient of Edison Medal

Benjamin G. Lamme, chief engineer of the Westinghouse Electric & Mfg. Co., received May 16 the Edison medal awarded by the American Institute of Electrical Engineers for "invention and development of electrical machinery." The Edison medal was founded by an association composed of friends and associates of Thomas A. Edison, and is awarded annually for meritorious achievement in electrical science, electrical engineering or the electric arts. The award of this medal is one of the highest honors that can be conferred upon an American or Canadian electrical engineer. and among those who have received it are George Westinghouse, Elihu Thomson, Frank J. Sprague, Alexander Graham Bell and Nikola Tesla.

This honor to Mr. Lamme follows closely his appointment to membership on the Naval Consulting Board, which also emanated from the recommendation of the American Institute of Electrical Engineers.

Among the achievements of Mr. Lamme in the engineering field may be mentioned the development of the alternating-current motor, the "harnessing" of Niagara Falls, the design of the equipment used in the electrification of the New York, New Haven & Hartford R.R., the Pennsylvania, the Norfolk & Western and other railroads.

Civil Service Examinations

United States

For United States civil service examinations listed below, apply to United States Civil Service Commission, Washington, D. C., or to any local office of the commission, for form 1312.

Engineer in forest products, $1860-$3000 per year; assistant engineer in forest products, $1200-$1800 per year, Forest Products Laboratory, Madison, Wis., May 27. File applications before May 27.

Chief of road survey party, $1800 to $2100 per year, transitman for road surveys, $1200 to $1800 per year, highway draftsman, $1200 to $1800 per year, Bureau of Public Roads and Rural Engineering, May 29. File applications before May 29.

Senior engineer and senior architect, Interstate Commerce Commission, $1800-$2700 per year, June 10. File application before June 10.

Valuation engineer, $3600-$4800 per year, and assistant valuation engineer, $2500-$3600 per year; technical staff, income-tax unit, Bureau of Internal Revenue, Treasury Department. No date specified.

ENGINEERING SOCIETIES

Calendar

Annual Meetings

NATIONAL CONFERENCE ON CITY PLANNING; 19 Congress St., Boston; May 26-28, Niagara Falls and Buffalo.

AMERICAN WATER-WORKS ASSOCIATION; 47 State St., Troy, N. Y.; June 9-13, Buffalo, N. Y.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS, 29 W. 39th St., New York; June 16-19, Detroit.

AMERICAN SOCIETY OF CIVIL ENGINEERS; 29 W. 39th St., New York; June 17-20, St. Paul-Minneapolis.

AMERICAN SOCIETY FOR TESTING MATERIALS; University of Pennsylvania, Philadelphia; June 24-27, Atlantic City, N. J.

AMERICAN CONCRETE INSTITUTE; 6 Beacon St., Boston; June 27-28, Atlantic City, N. J.

The Pittsburgh Chapter of the American Association of Engineers will give a banquet and ball at the William Penn Hotel in honor of the engineers of the Army and Navy who have returned from the service. **The Engineers' Society of Western Pennsylvania** and the **Pittsburgh Association of Members of the American Society of Civil Engineers** have been asked to coöperate in the program.

The Portland, Ore., Chapter of the American Association of Engineers recently elected the following officers: President, W. H. Marsh; vice-presi-

dents, A. H. McKeen, T. W. Saul and O. Laurgaard; secretary, R. W. Barnes, and treasurer, C. F. Thomas. A committee was appointed to consider the Oregon law for the licensing of engineers, as well as a committee to report on the pay of technical engineers in railroad service.

The Detroit Engineering Society held a joint meeting, May 16, with the Detroit-Ann Arbor Section of the American Institute of Electrical Engineers. The meeting was addressed by Col. R. A. Millikan. of the Council of National Defense, Washington, D. C., and professor of physics, University of Chicago, who spoke on the "Influence of the War Upon Scientific and Engineering Development in the United States."

The Society of Engineers of Eastern New York elected the following officers at the annual meeting held in Albany, May 12: President, James G. Blunt; vice president, John H. McElroy; secretary, Arthur Bibb, and treasurer, Edgar Croasdale.

The Tri-State Water and Light Association of the Carolinas and Georgia will hold its ninth annual meeting at Greenwood, S. C., June 17-19. W. F. Stieglitz, Columbia, S. C., is secretary-treasurer.

The Engineers' Club of Cincinnati held a joint meeting with the Cincinnati Chapter of the American Society of Mechanical Engineers, May 15. The meeting was addressed by Ernest F. Du Brul, on "Trade with South America."

The Rochester, N. Y., Engineering Society will hold its annual meeting June 13.

The Western Society of Engineers was addressed May 12 by E. M. Haas, of the Austin Co., who spoke on "Modern Tendencies in Engine-House Design."

The Colorado Society of Engineers held a special meeting May 13, at which resolutions were adopted opposing measures providing for a board of control of Denver and creating a public service commission.

The Rochester, N. Y., Society of Technical Draftsmen will be addressed May 29 by Maurice A. Wilder on "Application of Mathematics in the Drafting Room." The annual meeting of the society will be held June 26.

PERSONAL NOTES

HOMER L. FERGUSON, president and general manager of the Newport News Shipbuilding & Dry Dock Co., Newport News, Va., has been elected president of the Chamber of Commerce of the United States, having been a member of the Board of Directors since 1914. He was born in 1873 and was graduated from the United States Naval Academy in 1892 and from Glasgow University in 1895. For 11 years he was a constructor in the United States Navy, and in 1905 became general manager of the shipbuilding company of which he is now president. He is a member of the Society of Naval Architects and Marine Engineers, the Society of Naval Engineers, the Engineers' Club of New York, and the Army and Navy Club of Washington.

BRIG. GEN. DOUGLAS MCARTHUR, 42nd Division, U. S. A., has been appointed superintendent of the United States Military Academy. During the first three months after this country entered the war General McArthur served as chief of the Army censorship in this country, with the grade of major, Corps of Engineers. He then sailed with the Rainbow Division as chief of staff, with the rank of colonel. He was engaged in much of the actual fighting and has received decorations from the American, British and French Governments. Previous to the entry of this country into war, General McArthur was on regular station duty with the Corps of Engineers.

WILBUR H. JUDY, who since 1914 has been connected with the water-impounding system and has served as chief inspector of the operating department of the City of San Diego, Calif., has been appointed manager of operation of the city. His first engineering work was with the Allis-Chalmers Manufacturing Co., Milwaukee, and he was later employed on the hydro-electrict project of the Pacific Electric & Power Co. near Fresno, Calif.

EDWARD H. BOUTON and MAJ. EZRA B. WHITMAN, of the firm of NORTON, BIRD & WHITMAN, consulting engineers, New York City and Baltimore, former water engineer of Baltimore, who has recently been on duty at Camp Meade, Maryland, sailed from New York, May 17, for England, whence they expect to proceed to Poland to investigate the field there for the establishment of public utilities, such as water and sewerage systems, railroad and highway improvements. They do not expect to leave England for Poland until after the peace treaty is signed.

MAJ. CHARLES H. MILLER, Engineers, U. S. A., has returned to this country and has resumed his work in the firm of the Miller-Butterworth Co., Inc., engineers and contractors, Little Rock, Ark. He received his commission as major of engineers in June, 1917, and was sent to Deming, N. M., as constructing quartermaster of Camp Cody. He was later assigned to the command of the 2nd Battalion, 23rd Engineers, which sailed for France in the month of March, 1918.

M. MANCUSI-UNGARO and L. R. GILBERT have become associated under the firm name of UNGARO & GILBERT, civil engineers and architects, with offices in the First National Bank Building, Bound Brook, N. J. Mr. Ungaro was previously engaged in private practice in Newark, N. J., until entering Government work at Bound Brook. Mr. Gilbert was connected with the Calco Chemical Co. and previously with the New York State Engineering Department.

W. J. DOUGLAS, who recently resigned as engineer of maintenance, Panama Canal, and vice-president of the Panama Railroad Co., in which positions he has served since June, 1918, has returned to New York City and will resume his work as a member of the firm of Barclay Parsons & Klapp, consulting engineers. In the absence of Governor Harding during the past twelve months, Mr. Douglas was acting Governor of the Canal Zone.

C. GRADY CATES, for the past four years chief engineer of the Roanoke Iron & Bridge Works, Inc., Roanoke, Va., has resigned to become chief engineer and assistant general manager of the American Truck Body Co., which has recently been organized, with factory at Martinsville, Va.

MAJ. EDWARD STUART, Sanitary Corps, U. S. A., who recently received his discharge from the service after returning from the Balkans, where he was detailed as sanitary adviser to the Serbian Army and Government, has sailed for France as a member of the Tuberculosis Commission of the Rockefeller Foundation.

D. L. REABORN, for the past four years superintendent of the Mt. Rainier National Park, Washington, and formerly division engineer, Los Angeles aqueduct, has resigned as superintendent of the park to become chief engineer of the Western Willite Road Construction Co., with headquarters in Los Angeles.

LIEUT. E. B. STEARNS, Air Service, U. S. A., who was recently discharged from the service, has been appointed sales manager for the H. K. Ferguson Co., engineers and contractors, Cleveland. He was formerly associated with the Pitt Engineering Co., Pittsburgh.

CAPT. EDWARD STEIDLE, formerly 30th Engineers, U. S. A., and more recently attached to the First Gas Regiment, Chemical Warfare Division, has returned to this country and will resume his connection with the Carnegie Institute of Technology, in mining and field work.

J. W. HOWARD has finished his work in the Ordnance Department of the Army and has resumed the practice of engineering, specializing in roads and pavements, with testing laboratory in Newark, N. J., and offices at 1 Broadway, New York City.

J. D'ESPOSITO, assistant chief engineer of the Chicago Union Station Co., has been appointed chief engineer, succeeding THOMAS RODD, who, it is understood, will become consulting engineer. During the period of the war

Mr. D'Esposito served in the Emergency Fleet Corporation, wooden ship division, as assistant to James O. Heyworth.

BRIG. GEN. WILLIAM H. ROSE, U. S. A., director of purchase, Division of Purchase, Storage and Traffic, has resigned from the service and has become associated with Lockwood, Greene & Co., industrial engineers, as manager of the New York office. General Rose was a major in the Corps of Engineers.

CAPT. C. R. TWISS, for the past 14 years city engineer of Vicksburg, Miss., has resigned to become associated with the I. R. Packard Construction Co., Chicago, and will be in charge of the company's contracts in Arkansas.

EDWARD B. HAROLD, formerly of the New York sales office of the Universal Portland Cement Co., has been made manager of the highway department of the Clinton Wire Cloth Co., with office at 949 Broadway, New York City.

MAJ. A. C. KING, Construction Division, U. S. A., who has been in charge of the electrical section, has resumed his work as one of the chief officers of the Illinois Appraisal Co., with offices in Washington and Chicago.

R. L. SCHMID has been appointed assistant division engineer, Nashville, Chattanooga & St. Louis R.R., with headquarters at Nashville, succeeding J. L. FERGUS, appointed assistant engineer, as noted elsewhere.

FREDERICK A. RHODES, consulting engineer, San Diego, Calif., has been appointed city engineer. He is 39 years old and is a graduate of the Cogswell Polytechnic School, San Francisco.

H. E. TURNER, formerly assistant division engineer, Denver & Rio Grande Ry., Utah Lines, with headquarters in Salt Lake City, has become resident engineer in charge of concrete-highway construction, State Road Commission of Utah.

MARCH F. CHASE, formerly director, explosives division, War Industries Board, has become consulting engineer for the Leonard Construction Co., New York City. The offices of the company have recently been moved to 6 Church Street.

FRED J. DEUTSCHMAN, Aurora, Ill., has been appointed city engineer of Mitchell, S. D., succeeding S. H. Smith, who recently resigned. Mr. Deutschman was previously city engineer of Belleville, Ill.

RAY S. BLINN, formerly city manager of Westerville, Ohio, has been appointed city manager of Lapeer, Mich. He was previously director of public service of Mount Vernon, Ohio.

MAJ. CHARLES S. PILLSBURY, U. S. A., who has been attached to the Aviation Section of the Signal Corps in France in charge of construction work since 1917, has been made a member of the Legion of Honor by the French Government. Major Pillsbury was formerly assistant general sales manager, Chicago Bridge & Iron Works, Chicago.

LIEUT. JAMES R. COMLY, Engineers, U. S. A., has received his discharge from the service and has returned to the engineering department of the San Diego & Arizona Railway.

ALLEN H. STUBBS, formerly of the Department of Engineering, University of Nebraska, has become manager of the Kansas City office of HEDRICK & HUFF bridge engineers.

OLIVER G. SHAFER and ROBERT W. HANSON have become associated under the firm name of SHAFER & HANSON, general contractors, Caldwell, Ohio, successors to Oliver G. Shafer, highway contractor.

ELBERT M. CHANDLER, chief engineer of the Naches Selah Irrigation District, has resigned to become first chief engineer for the Washington State Reclamation Service, with headquarters at Olympia.

D. E. COUNTS, superintendent of bridges and buildings, Nashville, Chattanooga & St. Louis R.R., whose headquarters have previously been in Atlanta, is now located at Chattanooga.

ALBERT T. CANFIELD, assistant engineer, architectural department, Union Pacific R.R., with headquarters at Omaha, has resigned to become associated with the SHERMAN ENGINEERING Co., Kansas City.

CAPT. H. E. DARTON, formerly of the 162nd Depot Brigade, Camp Pike, has been appointed first assistant state highway engineer of Arkansas, succeeding JOHN P. HARPER, resigned.

J. L. FERGUS, assistant division engineer, Nashville, Chattanooga & St. Louis R.R., with headquarters at Nashville, has been appointed assistant engineer.

SAMUEL A. GREELEY, hydraulic and sanitary engineer, formerly at 64 W. Randolph St., Chicago, has removed to 39 W. Adams Street.

J. C. CORCORAN, assistant engineer, New York Central R.R., with office in Albany, has been appointed chief signal inspector, east of Buffalo, with headquarters at the same point.

FREDRICK W. CARPENTER, of Flushing, N. Y., has been appointed executive officer of the Wilmington, Del., Bridge Commission.

ENSIGN BERTRAM B. MOORE, U. S. N. R. F., has received his discharge from the service and has resumed his work with the engineering bureau of the City of San Diego, Calif.

MAJ. ARTHUR M. SHAW, Corps of Engineers, U. S. A., announces that upon his release from active duty about June 1 he plans to reopen his office in New Orleans for the private practice of engineering and will engage in hydraulic, railroad, industrial plant and river and harbor work.

F. J. BACHELDER, consulting engineer, Chicago, announces the opening of a new office in Washington, D. C.

WALTER DEUTCHER, acting city engineer of Aurora, Ill., has been appointed city engineer.

W. C. DICKEY, for the past six years city engineer of Conneaut, Ohio, has resigned to become associated with A. E. Vrooman & Co., Painesville, Ohio.

PHILLIP L. MINOR, engineer, National Tube Co., Pittsburgh, has been appointed borough engineer, Ellwood City, Penn.

JOHN ABERCROMBIE, for many years county surveyor, Alexandria, Minn., has opened offices at that point for the private practice of engineering.

OBITUARY

EMIL SWENSSON, consulting engineer, Pittsburgh, died in that city, May 13, at the age of 61. He was born in Sweden in 1858 and was educated in the public schools of Halmstad in a scientific course. He was graduated from the Technical Institute at Gothenburg, Sweden, in 1878. He came to the United States in 1880 and engaged in engineering work. In 1885 Mr. Swensson entered the service of the Phoenix Bridge Co. as draftsman, and two years later became connected with the Keystone Bridge Co., afterward the Carnegie Steel Co., of which he was made assistant to the chief engineer and later superintendent of the Keystone Bridge Works. Leaving the Carnegie Steel Co. about 12 years ago Mr. Swensson entered private practice, and since that time has been engaged in a large number of important works.

H. C. ALLEN, state highway engineer of Idaho, died at Sprague, Wash., May 4. He was appointed to the position of state highway engineer a year and a half ago. Previously he was city engineer of Great Falls, Mont. From Great Falls he went to Spokane, Wash., and laid out the irrigation system for the Hercules ranch. He was later employed as an engineer for the Day Bros. mine at Wallace, Idaho, and was also engineer at the Tamarack and Custer mine, at the time of his appointment as state highway engineer.

DOUGLAS W. TAYLOR, highway engineer of Multnomah County, Oregon, died in Portland, May 3. He was a son of the late D. W. Taylor, who for some years served as city engineer of Portland. Mr. Taylor was born in 1885 and was graduated from the University of Oregon in 1906. Since then he was engaged in engineering work in northwestern Oregon.

Rates for Industrial Insurance in State of Washington

The State of Washington has a monopoly of the industrial insurance business in that state. The advocates of this plan assert that it is the only method by which compensation benefits can be extended to all classes of risks which would be excluded by private corporations. The employers are protected by a state fund, and it is said they are well satisfied with the system. The accompanying table gives the rate per year per $100 of payroll for the various classes of industry. The information was furnished by Frank W. Harris, C.E., statistician for the Industrial Insurance Department, Olympia, Wash. Detailed information will be furnished on request by the industrial department.

COST OF WASHINGTON STATE INDUSTRIAL INSURANCE PER YEAR PER $100 OF PAYROLL*

Class	*Industries*	Cost
1	Tunnels, sewers, drilling wells, etc.	$2.64
2	Bridges and trestles, mill-wrighting, tanks, towers, etc.	4.19
3	Canals, piledriving, breakwaters, etc.	4.76
5	Carpenter work, plastering, roofwork, etc.	1.91
6	Conduit work, electric power plant, etc.	1.41
7	Railroad construction, logging railroad, etc.	2.82
8	Concrete paving, roadwork, etc.	1.20
9	Shipbuilding, etc.	1.36
10	Logging, sawmills, etc.	2.01
12	Dredging, etc.	1.43
13	Steamheat or power plants, etc.	1.34
14	Street and interurban railways	.95
15	Telephone and telegraph	.86
16	Coal mines	3.15
17	Quarries, gravel pits, etc.	3.16
18	Smelters, rolling mills, etc.	1.44
19	Gas works	.58
21	Flour mills, grain elevators, etc.	.85
22	Laundries and dye works	.34
24	Paper and pulp	.99
29	Cooperage, sash and doors, boxes, etc.	1.24
31	Building material, cement manufacturing, etc.	1.77
33	Fish canneries	1.01
34	Auto repair, foundries, machine shops, etc.	.76
35	Brick and tile, briquettes, etc.	1.02
37	Breweries, bottling works, etc.	.84
38	Textiles, cordage, etc.	.33
39	Foodstuffs, bakeries, etc.	.36
40	Condensed milk, creameries, etc.	.23
41	Lithographing, printing, etc.	.10
42	Longshoring, etc.	2.07
43	Packing houses, tanneries, etc.	.98
44	Cold storage, ice plants, etc.	.87
45	Moving pictures, theatres, etc.	.16
47	Creosoting piles, etc.	.77
48	Elective adoption	.35

*Averages for years 1913 to 1917.

Record Gyratory Crusher Built at Allentown, Pennsylvania

What is reported to be the largest gyratory stone crusher ever built has just been completed in the shops of the Traylor Engineering & Mfg. Co., at Allentown, Penn. The machine, which is shown set up in the accompanying view, is to be used for crushing limestone for chemical purposes, flux, etc. It has two jaw openings each 60 x 190 in. and an estimated capacity of 2500 tons per hour, reducing to 8 in. The crusher complete weighs about 800,000 lb., is 17 ft. 8 in. high from foundation to top of hopper and has a shaft 21 ft. long and 40 in. in diameter.

GYRATORY CRUSHER WITH OUTPUT OF 2500 TONS PER HOUR

In the view herewith, where it is set up in the shop, the enormous size may be well gaged by the men who are standing on the ladder.

The Canton Culvert and Silo Co., of Canton, Ohio, announces that Judge F. E. De Haven, of La Grange, Ky., has resigned his position as judge of the fiscal court of Oldham County to become their company's traveling salesman in Kentucky. It is also announced that L. W. Hurley, of Lansing, Mich., has accepted a position as representative in Michigan.

Daniel T. Pierce, formerly assistant to the president of the General Asphalt Co., has just returned from more than a year's service in France, and is temporarily established at Room 1031, 120 Broadway, New York City. Mr. Pierce will represent certain Franco-Italian interests and will also act for American manufacturers seeking business in France and other European countries.

The Northern Waterproofing Co., the Waterproofing and Construction Co., Inc., and the Standard Surfacing Co. give notice that they have amalgamated, with business address at 195 Lexington Ave., New York City. While these companies have combined, they will conduct business under their respective names.

The Minneapolis Steel & Machinery Co., Minnehaha Ave. and 29th St., Minneapolis, announces the extension and development of its New York office at 154 Nassau St. to facilitate the handling of domestic sales in the East. J. A. Teach, contracting, mechanical and construction engineer, is now making his headquarters at the New York office. C. W. Hadden will continue his duties as export manager.

Business Notes

The Railway and Power Equipment Co., Woolworth Bldg., New York City, which was recently incorporated to take over the business conducted during the past 20 years by Charles F. Johnson, in New York, Buffalo, Cleveland, Philadelphia, Chicago and Toronto, announces that it is receiving many foreign inquiries for machinery and equipment. It proposes to conduct a world-wide business in all kinds of new steel products, steam, electric and hydraulic machinery, railway equipment, machine tools and contractors' equipment. The engineering and construction departments will design and construct, and aid in financing, important enterprises at home and abroad.

The Westinghouse Electric & Mfg. Co., of East Pittsburgh, Penn., announces the appointment of A. E. Hitchner as manager of the mining section of the industrial sales department. Mr. Hitchner has had extensive experience in handling mining machinery, having been in charge of the Wilkes-Barre office of the company, and in his new position will manage the sale of apparatus for use in the mining industry.

The Blaw-Knox Co. of Pittsburgh has taken over the manufacture and field operation of the Uni-Form system of reinforced-concrete floor and roof construction, and has incorporated it in the steel forms department of the company. Nils F. Ambursen, chief engineer of the Ambursen Hydraulic Construction Co., will assume the duties of chief engineer of the building form department, and W. L. Church, formerly of the Westinghouse Church Kerr Co. and of Lockwood, Green & Co., engineers, is retained as consulting engineer on the operation of the Uni-Form system.

Trade Publications

The following companies have issued trade publications:

The C. H. & E. Manufacturing Co., Inc., Clinton and Mineral Sts., Milwaukee, Wis.; folder, 7½ x 11 in., four pages, illustrated; describes the C. H. & E. expansion joint for pipe lines and its installation, with piping system.

The Truscon Steel Co., Youngstown, Ohio; folder, 8½ x 11 in., four pages, illustrated; describes the use of "mesh" and "rib" metal for reinforcing concrete roads.

The Portland Cement Association, 111 W. Washington St., Chicago, Ill.; booklet, 6 x 9 in., 19 pages, illustrated; contains "Facts About Concrete Roads."